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Relics

WE AMERICANS have a comparatively short history but a record of large achievement.

Our faces are set toward the rising rather than the setting sun, our interest focused rather upon the road ahead and the possibilities before us than upon the conditions from which we have come and the way that we have followed.

We work intensely, adopting readily any development that will add to our speed and efficiency and kicking carelessly aside that which has served our purpose.

But would we not get more out of life's journey if we stopped a minute to look at the scenery, to worship at some historic shrine, to see the present as a product of the teeming past and to appreciate from what small beginnings we have come to be what we are?

Up to comparatively a few years ago there was intact upon the shores of Newark Bay the first steam plant ever run on this side of the Atlantic—a Newcomen engine brought over when Watt was in his teens.

What a shame that this cornerstone of the power industry in America should have been used for junk.

The big Corliss Beam Engine that ran the Centennial Exposition and afterward the Pullman Works was broken up because no institution, public or private, would provide it shelter.

The great reciprocating engines, masterpieces of the steam engineering of the past generation, are being discarded by electric stations, mills, steamships and pumping services, and in a few years we shall have nothing by which to know them but their blueprints or pictures, peopled with high-hatted observers carrying canes.

Would it not be a gracious act for some of the beneficiaries of this intensive industrialism to provide for the preservation of such conspicuous examples of engineering achievement as stepping stones for those who, from the vantage point of coming generations, wish to retrace the progress of the art and sense the times when what they know was yet undreamed, but man worked wonders with his ponderous means?

F. R. Low

The Metric System

IN A recent publicity release received from the American Institute of Weights and Measures the question is asked, "Have any of the utilities asked the professors and educators to help keep the metric system in the school texts?" The suggestion contained in this question can hardly be taken seriously, as there seems little reason to believe that the utilities are at all interested one way or the other regarding our adoption of the metric system. Power utilities measure their product in units common to both systems and the telephone, telegraph and railroad render a service not measurable in units of either system.

But, after all, whether or not the metric system is made compulsory in the United States has little bearing upon the advisability of teaching this subject in our schools. The fact remains that many of the leading nations of the world use the metric system exclusively, and some knowledge of it is necessary for those having commercial relations with these nations. There is every bit as much reason for teaching the metric system as there is for teaching foreign monetary systems or early American history, and no one has suggested removing these from the school curriculum.

The American Institute of Weights and Measures would do well if it left the question of what shall or shall not be taught in schools to men whose business it is to understand the work of educating the future generation.

Management in Maintenance

MORE management in maintenance and less of the haphazard method of repairing equipment only when it fails to function will not only increase production, but reduce the cost of maintenance. The "fix-when-broken" style of taking care of machinery is not confined to small plants alone, but it still exists in many of the large establishments. In these places the equipment that comes to the repair shop for overhauling and repair is generally a pretty sorry looking mess.

Motors allowed to run with bearings worn and the rotor rubbing on the stator core until the insulation on the coils is destroyed, are an example of such neglect. Proper attention to lubrication and an inspection of the air gap three or four times a year would prevent the destruction of the winding, the loss in production during the time the motor is being repaired or being replaced by a spare, and the cost of the repairs. The bearings, when they are worn, have to be changed and this might better be done before they have worn so far as to cause injury to the windings. If those responsible for maintenance were aware of the conditions, the bearings could be changed at a convenient time without delaying production. If a spare motor is available, it could be put into service and the one with low bearings brought to the shop for general cleaning and repair. The latter is what must be done after the windings are destroyed, so why not before, thus saving the cost of rewinding and an unexpected shutdown.

It is not uncommon to find that those in charge of maintenance take the attitude that because spares are available, it is not necessary to make periodic inspections of the equipment in service. Where spare equipment leads to such conditions, it loses a large part of its economic value. Instead of decreasing interruptions to production, it actually increases them and increases repair costs.

The chief purpose of spare equipment should be to replace other equipment that needs to be taken from service for a general overhauling, cleaning and the replacement of worn parts, before a breakdown of the machine has occurred. When this is done, few occasions will arise where the spares will have to be used in emergencies and expensive repairs will be the exception. Take care of the little things and the larger ones will generally take care of themselves.

Shouting from the House Tops

SHOUTING from the house tops is recognized as the pastime solely of the indiscreet or of the exponent of Babbitting. Still, American power-plant equipment builders might well get this habit to the extent of better proclaiming the merit of their wares.

A large class of intelligent business men believe that the products of the Old World have superior merits impossible to obtain in those of American manufacture. Even where such equipment as steam and oil engines is concerned, the European designs seem to these people to possess qualities unattainable here at home.

Recently, it was announced that Columbia University had purchased two Diesel engines from a German firm, for its power plant. One explanation reported as given by the University's spokesman was that American firms did not know how to build oil engines.

That anyone connected with an educational institution should hold such views is due primarily to a failure of our engine builders to proclaim properly the merit of their wares. With the yearly output of American oil engines much greater than the output of Germany, it is obvious that the home product cannot be so far inferior.

Our home machine builders should rid themselves of any inferiority complex and boldly offer records to pit against records, designs to compare with designs. In other words, our engine builders must find every possible outlet for the telling of their story. When this is done, such discouraging incidents will not occur.

Prosperity and Presidents

SO FAR, even though it is the year of a Presidential election, no let-down in industrial or business operations has been noted. All the various agencies and institutions reporting conditions show some gains for the current year over last year's operations. Of course this improvement is not uniform, certain lines of endeavor showing recessions. However, such recessions are more than compensated for by the increases shown by other fields.

This condition suits the facts in the case better than the bad times experienced in some past national campaign years. It takes but little consideration to make evident that there is no basic reason why Presidential years should be bad years. It is not possible that the choice of one man over another can have such immediate and far-reaching effects that business needs to slow down operations before election until it sees which way the cat is going to jump.

Against their own best interests, however, some seem to feel that such a pause is advisable. If they hurt only their own interests by so doing, no objection could be made to such a course. But the fact is that any slowing down of one business curtails operations in all others.

And there is another, more serious, aspect of the mat-

ter. Men are, in some of their actions, quite like sheep. They tend to follow a leader. So this slowing-down process carries with it a certain psychological contagion, such as exists in times of business panic. Those subjected to this contagion are quite likely to become overtimid, afraid to carry on their affairs at a normal pace.

What business and industry should do during years of Presidential campaigns is to attend strictly to their own affairs. They can be confident that there is no immediate effect to be expected from a change in chief executives. And by keeping their operations at a high and profitable level, they will be just so much better prepared for any recessions that may occur later.

Higher Steam Pressures Here to Stay

HIGHER steam pressures (six hundred pounds and up) have advanced to the point where it is safe to predict their increasing application to central stations and also to a large group of industrial process plants.

For years the theoretical advantages of high pressures have been known and urged, but only in recent years have they been tested in practice on a scale to inspire confidence in the rank and file of plant designers and operators.

It is significant that the latest report of the N.E.L.A. Prime Movers Committee on higher steam pressures and temperatures is almost wholly favorable to high pressures. This committee, in the opening paragraphs of its report, says:

"Economy data from ten representative high-pressure and temperature power plants have shown a realization of theoretical gains from higher steam pressures and temperatures. Heat-consumption rates of these stations . . . are the ultimate proof of value from extended steam conditions. Higher steam pressures do not cause lower turbine efficiency. . . . Water-rate curves show high-pressure machines to have exceedingly flat characteristics, furnishing a reason why the value of high pressures is not confined necessarily to base-load plants. Extraction gains are increased by pressure advances.

"Experience with plants operating at six hundred pounds and over shows a justification for higher rates of steaming per square foot of steam releasing surface. . . . Steam-carrying capacity of tubes is greatly increased. . . ."

Scaling is noted as the only real difficulty with high pressures, and that has already been solved in the central stations by checking condenser leakage, using evaporated makeup and maintaining a small concentration of trisodium phosphate in the boiler water.

This looks like a pretty good case for high pressures. "But," will say the still skeptical, "granting all this, we must think of dollar economy, not B.t.u. economy." The Prime Movers report says little on this point, but the conclusions quoted indicate that it must have been given consideration. Moreover, the consensus of opinion in a discussion of the subject at the spring meeting of the A.S.M.E. in Pittsburgh indicated that the increased cost of a high-pressure plant is a small matter. Savings in piping, condensers and coal-handling and burning equipment largely offset the increased cost of certain other items. If this is the case now, it is reasonable to expect that increased production of high-pressure equipment will wipe out any disadvantage in first cost and with it the last obstacle to the general adoption of high pressures in central stations.

The situation in industrial plants is somewhat different. Where all power required can be generated from process steam at present pressures there is no object in going to higher pressures unless power can be sold outside. On the other hand, the process plant with high ratio of power to process-steam demand can save far more coal proportionately by going to higher pressures than can the condensing station. The matter of operating experience and developing equipment is being largely solved for such plants by the central stations.

High percentage of makeup with aggravated feed-water conditions is a more serious hurdle, since high-pressure boilers must have pure water. The feed-water problem has already been solved in a number of process plants by delivering steam from high-pressure boilers or turbines directly to evaporators supplying process steam. A great increase in such installations in the near future seems likely. This development will naturally be limited to plants requiring large amounts of power, but these form an important group in the industrial field.

First Cost Not the Only One

THE futility of trying to obtain continuously something for nothing has often been shown, but with little effect upon the thinking of many who purchase power equipment. Lowest price is too frequently the guide to buying, notwithstanding that the fallacy of this policy has been established by almost countless examples. Price should be a factor, but not the only one, even when the material is obtained on supposedly rigid specifications. Having goods supplied on specifications is no guarantee that the intent of the specifications is met, though apparently fulfilled.

One of the requirements in leather belting specifications is that the leather will not wrinkle when bent about a given radius. Belly stock, which is supposed to have no place in the construction of a good belt, can be treated in a way that it will pass such a test. It then appears, except to an expert, to be of a high grade. Many other tests for leather are just as misleading unless applied by an experienced belting engineer. Even when all the good wearing qualities are obtained, the belt may be a poor transmitter of power, as this quality depends very largely on the treatment given the hair side. With all these uncertainties, it is little wonder that buying on lowest price or a specification has led to many costly experiences in belting.

In one instance, where this policy was followed by a purchasing agent, conditions became so bad in the operation of the plant that something had to be done to reduce lost time of the production machinery. When this situation was finally cleaned up, the purchase of belting and other equipment was in the hands of competent engineers. As a result, although the price paid the manufacturer for belting was about double that originally paid, the cost of belt drives in the plant was materially reduced. This was accounted for by the longer life and reduced maintenance costs of the better-grade belting used. Also to this must be added a reduction in power costs and an increase in production due to fewer shutdowns.

Intelligent buying is not purchasing the highest-priced material nor the lowest, but selecting that best suited to the job, all things considered. These include not only the first cost, but the cost of operation. When products are compared on this basis, the cheapest in first cost will frequently be found to be the most expensive in final cost.

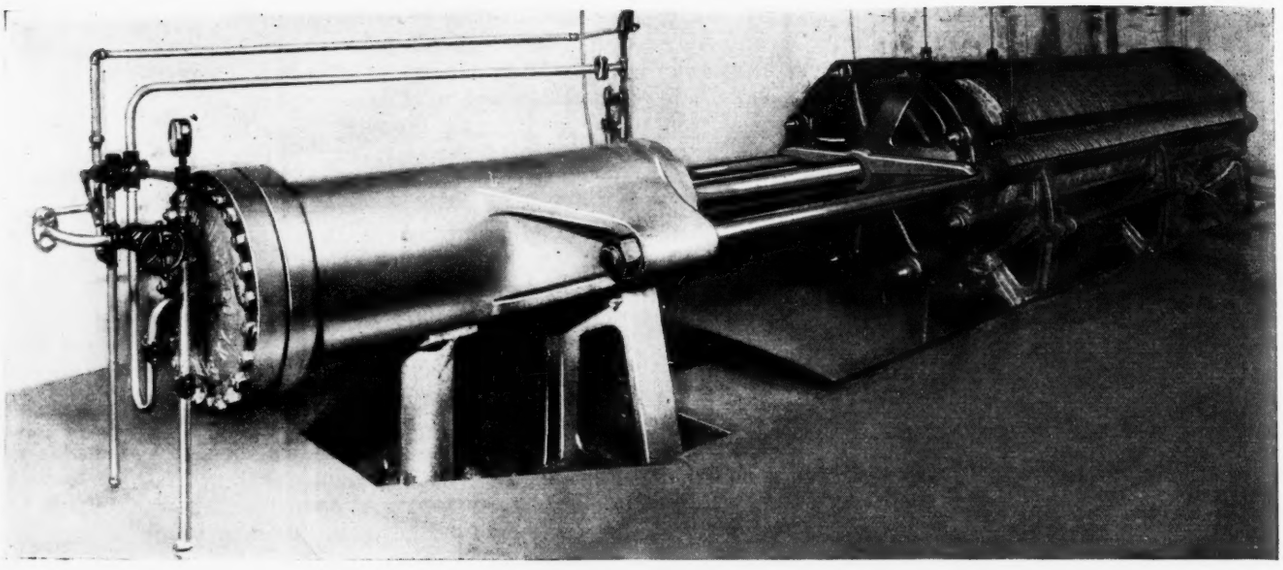

Fig. 1—A Vogt wax filter press

Producing Artificial Winter
In the Oil Industry

By N. H. Hiller, Jr.
Engineer, Filter Manufacturing Company

As is the case with many industries, such as candy making and rayon silk manufacturing, the oil industry owes much of its success to the refrigeration service.

The market value of any oil depends largely upon its ability to remain in a liquid state with little regard for the temperature existing. Those of us who own and drive automobiles doubtless realize the value of the oil that will begin to flow the very moment the motor is started, and we likewise know of the folly of using an oil that will not flow at very low temperatures. Only by means of refrigeration can modern oils be treated so that they will remain liquid at low temperatures.

Historically, it may be said that the cold winters in the western Pennsylvania oil fields first brought out the application of cold or refrigeration to the oil industry. At first, the low pour and cold test oils were made only in the winter time, but since then mechanical refrigeration has enabled the refiner to manufacture oils of a much lower cold and pour test than would ever be possible in the latitudes of the United States in winter.

The crude oil in the condition in which it leaves the well is conveyed to the refinery, where it is introduced into crude stills. These stills remove the most volatile constituents of the oil by distillation with heat, and these highly volatile constituents are placed in suitable receptacles to be used later in the manufacture of gasoline, kerosene and other highly volatile products. Structurally, these crude stills are simply cylindrical vessels some 15 ft. in diameter by 40 or 45 ft. in length, suspended by means of rings from a concrete, steel or other framework. Around the bottom half of the crude still is the firebox using fuel oil, coal or coke breeze. Arranged in the bottom of each still is a series of pipes called a spider. These pipes are connected to a steam line, so live steam may be blown through the spider into the still itself.

Where we desire to run for a reduced crude "bottom," or residual, in the still after distillation, the operation is carried on with the use of steam in the spider coils. Owing to the fact that cracking or breaking up of hydrocarbon molecules begins at a temperature around 575 deg. F., the use of steam in the spider coils will keep the oil in the still at a temperature below 575 deg. during the distillation process. It will be seen, therefore, that when we wish to run the still to a residual bottom we add steam during the distillation process, and when we wish to run the still to a coke bottom we omit the steam during the distillation process.

From the crude stills the reduced crude oil, as the residue is now called, is conducted by pipes to the paraffin-coke stills. Here the process is run to coke, omitting the spider steam, and the paraffin distillate used in the chilling plants is removed as an overhead cut of about 35 deg. Baumé. In order to cleanse this distillate before further processing, it is conducted to the paraffin agitators, where the unsaturated hydro-carbons, sulphur,

*Abstract of paper presented before the American Society of Refrigerating Engineers, Detroit, Mich., June 4, 1928.

dirt and other impurities are removed. This purification process is carried out by treating the paraffin distillate with concentrated sulphuric acid.

The sulphuric acid working on the distillate in combination with water and assisted by compressed-air agitation, gathers together all the unsaturated hydro-carbons, the sulphur and other impurities into a sludge, which is precipitated to the bottom of the agitator to be drawn off. The acidulous oil is then neutralized in a second agitator by means of a caustic-soda solution and, after being washed and cleansed, is ready for processing in the chilling plant.

Pressing Out the Wax

In the chilling plant the paraffin distillate is chilled and the wax from the paraffin distillate is pressed out by filter presses, after which the process divides into two separate operations. In the first of these actions a series of sweating operations drives the oil from the wax by the application of the heat. The wax, now thoroughly freed from any oil, is filtered and then packed, ready for shipment. The oil leaving the presses from which the wax has been removed by the pressing operation is termed the "pressed distillate." From the presses this pressed distillate is conducted to the re-run stills, where it is further fractionated by the application of heat. Here again, steam is introduced to the still to prevent cracking, and the lighter or more volatile cuts are taken to form the lighter lubricating oils, while the remaining oil in the still is used for cylinder stock or other heavy oil. After the re-run distillation operation, the oil is further processed by means of agitators which remove any unsaturated hydro-carbons that may still remain or have been formed during re-run distillation, and then is placed in storage. Sometimes it is necessary to filter this oil, but such an operation is not always of necessity. So much

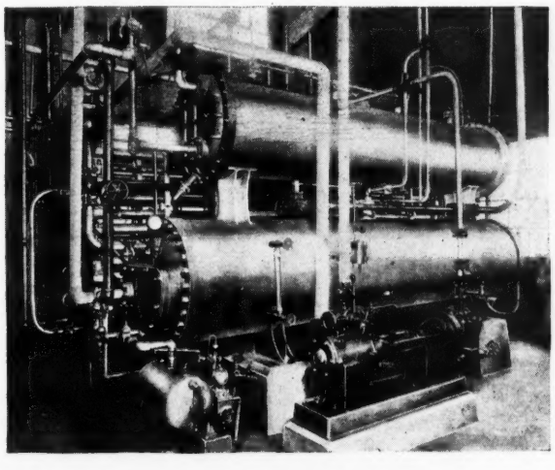

Fig. 2—An absorption system in general use

for a brief description of the manufacture of a paraffin-base oil.

After the paraffin distillate is purified in the agitators, it is piped to the chilling plant, where the first step in the removal of the wax is the chilling of the wax distillate itself. Where the wax distillate is at a very high temperature in coming from the storage tanks or agitators, a chilling temperature may at first be obtained by the use of water. As the temperature is lowered, the wax is thrown out of the oil in the shape of small wax crystals, which have the consistency of warm soap. These crystals tend to retard the flow of the wax through any chilling medium.

The chilling mediums by which refrigeration is applied, are called chilling machines, and in the United States there are two general types. The first of these types is what is termed the "double pipe chilling machine." As usually constructed, it consists of an 8-in. pipe which surrounds a 6-in. pipe. The cooling medium is circulated

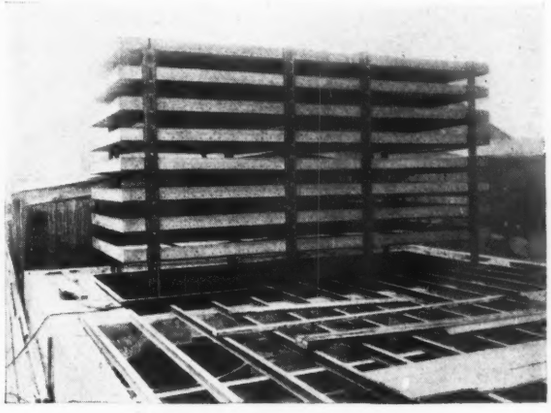

Fig. 3—A set of sweat pans

between the two pipes, and the whole process reminds one of the familiar double-pipe condenser. Inside of the 6-in. pipe there is a screw conveyor which assists the wax in its flow from one end of this pipe to the other. The screw conveyor is usually driven by chain sprockets on the extension of the shaft at one end, as shown in Fig. 4, but other drives are possible. The conveyor is absolutely necessary to move the congealed wax along with the oil.

Design of the Chilling Machine

The chilling-machine sections are generally assembled in any number up to twelve, and are connected by suitable return bends. Less than four sections per chiller are as a general rule rarely used, since one small press would require at least this number. Usually, all chiller sections are connected in series, so that there is no danger of plugging up of any of them, due to congealing of the wax in the oil. Standard chilling-machine sections contain approximately 50 to 55 sq.ft. of surface, and the rate of heat transfer between the oil and cooling medium of a double-pipe chilling machine is around 4 to 5 B.t.u. per sq.ft. per deg. F. of mean temperature difference per hour. At this rate one section will chill approximately 25 barrels of distillate from 100 to 20 deg. F. in 24 hours, permitting the recirculation of the foot's oil, one of the products from the sweaters.

Power Required

On account of the heaviness and hardness of the wax which is crystallized out of the paraffin distillate, it is necessary to use considerable power to drive the chilling machine. Where approximately 5 horsepower is necessary, larger motors, such as 7.5 are generally used. If, however, one has a large number of chilling machines to be driven from a lineshaft by belt or shaft, a motor large enough to take care of all heavy requirements of the chilling machine is generally supplied. If a chiller gums up and apparently sticks, the motor will then have enough surplus power to take care of the immediate requirements. It might be mentioned here that belts are an unsuitable type of drive for chillers, owing to the fact

that there is generally moisture in the room in which the chilling machines are located and that belts become hardened and slip. A slipping belt will always cause a great deal of trouble, permitting the chiller to freeze up and necessitating the use of warm brine to thaw the machine out, with a consequent loss in capacity of the plant.

The second type of chilling machine used in the United States is similar to an ice-cream freezer. It consists of two vertical shells, in the inner of which is a power-driven paddle wheel, arranged so that, upon being revolved, the inertia of the oil forces the blades firmly against the shell. The deposit of crystallized wax on the shells is thus avoided and the insulating effect of such a deposit is obviated. The cooling medium, brine or other suitable means, is circulated between the two shells, the transfer of heat from oil to brine being through the inner shell. This is, in effect, a very large double-pipe apparatus and is excellent for temperatures down to 20 deg. F. Below this temperature, however, the chilled paraffin has the tendency to adhere to the paddles, increasing the resistance and thus the power requirements. Inasmuch as this type of machine is vertical, it has a small floor-space requirement.

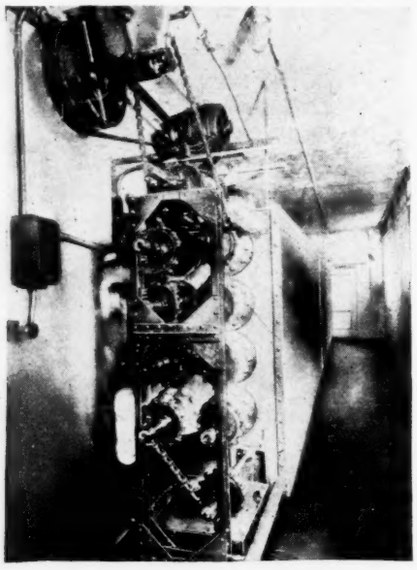

Fig. 4—A chilling machine

Kind of Refrigerating Machine

For furnishing the refrigeration required in a chilling plant, both the absorption machine, Fig. 2, and the compression machine are used. Opinion is largely divided as to the relative merits of each type. Each, of course, has its own particular application, and the refiner who is in the market for the purchase of refrigerating machinery for use in a paraffin-wax plant, must base his purchase of this equipment on local conditions. Both are being used successfully in refineries throughout the country.

On account of the rather large amount of wax contained in most paraffin-base oil, it is generally necessary to remove this wax in two or three separate operations. This is generally carried out by means of cooling the paraffin distillate from 90 to 100 deg. F. storage temperature to around 55 deg. for the first chilling. The paraffin distillate, with the wax now in crystalline form, is then conducted to the filter presses, Fig. 1. Here the wax is pressed out under high pressure, around 500 lb. per sq.in. and the wax-free distillate for this temperature is returned to the chilling plant. Immediately upon its return to the chilling point this "half-pressed distillate," as it is generally called, is conveyed to other chillers, where the temperature is brought down to around 20 deg. F. From these chilling machines the half-pressed distillate is again conveyed to the presses, where the remainder of the wax for this temperature is removed. If it is desired to have an oil of lower cold test than 20 deg., a third pressing is resorted to, but this process is not always necessary.

Handling the Distillate

As the paraffin distillate is brought from the storage tank, it is cooled primarily in atmospheric-type coolers, made of very large pipe, by means of water. This is a cheap form of refrigeration, especially when the paraffin distillate has a temperature of around 100 deg. F. Since even here the paraffin distillate sometimes is rather sluggish, a ram pump is necessary to assist this material through the water coils. From the water coils the paraffin distillate is conducted to a series of power or steam pumps, Fig. 5, which force the distillate through the first set of chilling machines. From the first set of chilling machines, which cool the paraffin distillate to about 55 deg. F., it is again forced by steam ram pumps to the hot, or high-temperature, filter presses, where the first wax is taken out. From here the half-pressed distillate is forced by other power pumps through the second set of chilling machines, where steam ram pumps take up the liquid and carry it to the second, or cold, pressing.

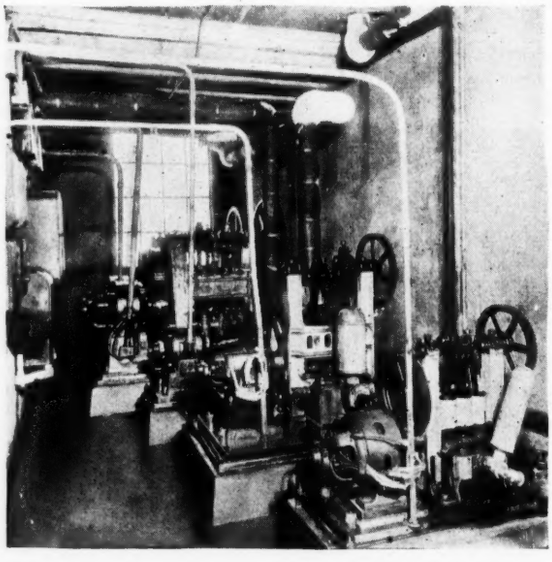

Fig. 5—Pumps for handling distillate

We may divide cold settling into two main methods: first, by means of the box type; second, by means of the tank type. The box type is the older system. This apparatus essentially consists of a series of rooms provided with refrigerating coils, these rooms containing rectangular tanks in which the temperature is maintained at about 0 deg. F. In the tank type of cold settling a standard vertical cylindrical tank with a height of from 80 to 90 per cent of the diameter is employed. In order to supply sufficient refrigeration, coils for circulating the cooling medium are provided in horizontal layers at the top of the tank, thus permitting a natural circulation of

the oil during the cold settling process. As the operation proceeds, the amorphous wax is precipitated to the bottom of the tank, and by means of the try-cocks the operator is able to determine the position of the settled stock and the petrolatum, the settled stock being that from which the petrolatum has been precipitated.

Brine is generally used for chilling and the temperature is kept somewhere between 10 and 20 deg. F., although sometimes a lower temperature is needed. Coils of relatively small diameter are used, 1.25 in., 1.5 in. and 2 in., as a greater amount of surface may be covered with a small coil, allowing also a smaller volume taken up by the coils installed.

Amount of Refrigeration Needed

Approximately 6 to 8 tons of refrigeration per 100 barrels of charge will meet ordinary requirements. Inasmuch as most plants are operated so that only about half of the tanks are used at one time, a refrigerating capacity of about five tons per day per 100 barrels of the charging capacity that is cylinder stock and naphtha, will suffice.

If very cold brine is applied to the mixed solution in the settling tank at the beginning of the process, the wax will harden on the coils to such an extent as to insulate them from the surrounding oil. It is, therefore, considered wisest to cool the mix in the settling tank very slowly, especially at first. By charging the mix at a temperature around 100 deg. F., this water or other cooling mediums may be used. At times a set of auxiliary cooling coils is introduced into a cold-settling tank and the cold bright stock from an already finished tank may be pumped through these auxiliary coils, thereby reducing the required amount of refrigeration.

The cooling process is carried at a certain speed, depending on the constituency of the mix involved and also on the final temperature of the process. Usually, when the temperature of the oil has reached its lowest limit, the refrigeration is cut off and the mass permitted to settle for about 24 hours. The bright stock is then pumped off through the upper suction line or swing line, which has already been mentioned, and the petrolatum is removed from the bottom. At times there is another product removed called the "half-settled stock," or that substance which lies between the settled bright stock and the petrolatum, at the bottom of the tank. All refiners, however, do not remove this material. Since both the bright stock removed from the top of the tank and the petrolatum removed from the bottom contain considerable naphtha, it is necessary to remove this naphtha before further process is taken up. It may be removed by means of steam stills, or stills in which the heat is applied by means of steam coils. The bright stocks as taken from the cold-settling plant are ready for compounding into various cylinder and motor oils. They must, of course, be thoroughly filtered before use. The petrolatum, after having been decolorized and treated, is a basis for the various petroleum jellies known to the trade and for ointments of the petroleum jelly base.

Are Industrial Power Costs Low Enough?

WHEN industrial power is investigated to determine what part it plays in the cost of finished products, it is evident that much improvement can be made. Power is, in some plants, bought where it should be made, while in others it is made where it should be bought. In some plants power costs are high because sufficient use is not made of improved designs of equipment that are now available, often because of difficulties in the way of financing new purchases. Heat and power are wasted, when changes in general layout, operating methods, or methods and equipment for transmission and application might effect big savings.

The importance of these things to the engineer in charge of industrial power is so great that *Power* plans to treat them with increased emphasis. Beginning with the September 4 issue, in which a general survey of all of these topics will be given, *Power* will show, principally by examples from successful practice, how industrial costs can be lowered through better engineering.

How to Store Coal

*With Minimum Fire Hazard**

By A. A. Potter and H. L. Solberg

Dean of Engineering, Purdue University

Ass't Prof. of Mechanical Engineering, Purdue University

THERE are two fundamental reasons for storing coal: (1) To insure a continuous and uninterrupted supply, and (2) to take advantage of seasonal fluctuations in price. It is customary for public utilities and manufacturing concerns to carry on hand a supply sufficient for from 30 to 90 days operation as a safeguard against interruptions over which the operating companies have no control. Stocks carried in storage by some public utilities are sometimes over half a million tons.

The demand is seasonal with the slack period occurring during the spring and summer months. Most of the labor difficulties in the coal mines can be traced to the overdevelopment of the mining industry which is required to meet the peak demand. As a result many mines are operated only part of the time and on a hand-to-mouth existence. The price of coal consequently varies, and it can generally be purchased at a lower price during the spring and summer months.

Spontaneous Combustion

Coals may deteriorate in heating value and slack or disintegrate during storage, and in extreme cases are liable to spontaneous combustion.

Experience has shown that all bituminous coals can be stored without danger from spontaneous combustion; yet practically all have been known to ignite spontaneously under unfavorable conditions. It is generally agreed that direct oxidation is the cause of coal-pile fires. If a lump is broken, the new surfaces have a marked affinity for oxygen. Absorption of oxygen from the air is accompanied by the generation of heat. The extent to which this action takes place depends upon the kind of coal. It is negligible in anthracite and is most serious in sub-bituminous coals and lignites. In general, it increases with the oxygen content. Freshly mined coal absorbs oxygen rapidly during the first week and at a slower rate thereafter. When the surfaces have become "satisfied," the action ceases. It is on this account that 75 per cent of the coal-pile fires occur during the first ninety days of storage. Being a surface phenomenon, the extent of surface is the most important factor. It increases rapidly with a reduction in the size of lumps.

There is no danger in storing screened lump that will pass over a screen having 1½-in. openings because the total exposed surface is small and the air circulates freely through the pile. Therefore, the slight heat produced by slow oxidation is immediately removed. If the lumps are small, the surface exposed for the absorption of oxygen is large and the ventilation may be inadequate to remove the heat generated.

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To Avoid Spontaneous Combustion

1. Store only lump coal in which the smallest size will not go through a 1½-in. opening. Circulation of air through the pile will remove any heat. The coal should not be dropped a greater distance than necessary if a bucket is used, as this increases the amount of fines. If slack or screenings are stored, they should be placed in horizontal layers to a maximum depth of five to eight feet and thoroughly compacted by a caterpillar tractor. Run-of-mine or unscreened coal should not be stored. If it is necessary to do so, care must be exercised to avoid segregation of the lumps and fines. Under no circumstances should freshly crushed coal be stored.

2. Coals that have a reputation for easily igniting spontaneously should be avoided. Anthracite and semi-bituminous coals can be handled with safety in almost any manner. Sub-bituminous coals and lignites are stored with considerable risk.

3. Store coal on well drained, level and unventilated ground. Storage on cinders is dangerous because the porous bed permits oxygen to gain access to the bottom of the pile. Drain tile should not be placed directly under a coal pile.

4 Avoid all sources of heat such as steam pipes, flues, sewer vents, etc. Coal piled in warm weather will fire more easily than coal piled in the winter. Foreign material such as wood, waste, paper, rags, etc., will quickly start a fire if heated to a moderate temperature.

5. Watch the temperature of the coal. This can be done by driving pipes into the pile at intervals and lowering a thermometer down the pipe. Such pipes should be plugged so as not to act as ventilating ducts. If 140 deg. F. is found, the coal should be watched carefully. If the temperature rises quickly to 180 deg. F., the coal should be dug out immediately and used. Once started, a coal-pile fire can best be controlled by digging out the burning coal. A waterproof cake generally forms over the burning spot so that water is of little use in combating the fire unless introduced through pipes driven into the burning zone.

6. Underwater storage is a means of absolutely avoiding spontaneous combustion, but the cost is high.

Careless piling of unscreened coal results in the segregation of sizes, with the fines in the center, and this is one of the main causes of coal-pile fires. Oxygen can readily gain access to the fines through the lump coal in the bottom and sides. A point is likely to exist where the heat is generated more rapidly than it can be removed by the poor ventilation in the fines, and a dangerous temperature will soon result. Air is continually circulating through the average coal pile on account of variations in barometric pressure, the influence of wind, etc. Deliberate ventilation of a coal pile by piping systems is not recommended, as spots may exist where the ventilation is inadequate and the oxygen supplied may cause trouble.

If lump coal is stored, the ventilation is sufficient to remove the heat generated at the relatively small surface of the coal. If the coal is small, the ventilation may be inadequate to produce any appreciable cooling effect, and at the same time may furnish a continuous supply of oxygen to the large surface presented by the coal.

The effect of sulphur upon spontaneous combustion has been greatly exaggerated. The oxidation of the pyrite (FeS_2) does result in the generation of heat, but not in sufficient quantities to cause a fire. The heat so produced may raise the temperature enough to speed up the rate of oxidation of the coal, but it is only a contributory factor in any case. The oxidation of the pyrite results in the disintegration of the coal and is harmful to the extent that fresh surfaces are thus exposed for the absorption of oxygen.

Weathering of Coal

Any absorption of oxygen by coal results in a decrease in the heating value. The loss of heating value has been exaggerated in the past. According to results of experiments conducted by the Bureau of Mines[1] and by the Engineering Experiment Station of the University of Illinois[2], the actual loss of heating value per pound varies with the kind of coal and the length of storage, but is quite small with the better grades. Semi-bituminous coals lose in heating value about one per cent in one year, two per cent in two years and not over three per cent in five years. The loss of heating value of bituminous coals depends upon the quality of the coal. They may lose one per cent during the first month and more slowly thereafter with a loss in five years of from three to six per cent. Anthracite is not affected by being piled in storage.

There is a prejudice among some power-plant operators against the burning of stored coal. Such coal generally contains a larger portion of fines than unstored coal because of breakage caused by careless handling, and slacking or disintegration caused generally by the swelling of the pyritic sulphur when oxidized during storage or, in the case of high moisture coals, by shrinkage upon loss of moisture. Such coal undoubtedly does require a higher draft and a thinner fire for its combustion, and the fires will require closer regulation. Stored coal does not ignite as quickly and burn as freely as freshly mined coal because of the absorption of oxygen by the unsaturated hydrocarbon compounds in the coal. As these difficulties, as well as loss of heating value, are caused by surface phenomena, they can be minimized by the storage of lump coal. In any case they are generally exaggerated.

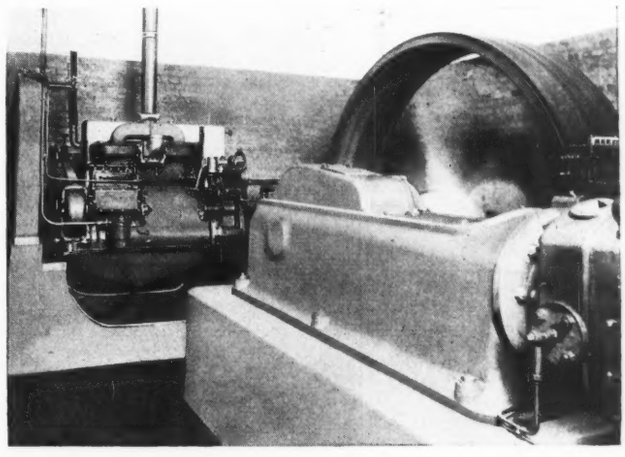
[1]Bureau of Mines Bulletin 136.
[2]Engineering Experiment Station, University of Illinois, Bulletins 46 and 97.

High-Speed Diesel Drives Air Compressor

By G. Grow

AN INTERESTING application of Diesel power is shown by the accompanying illustration. It consists of a two-stage 16x10x14-in. air compressor of the horizontal type driven by a four-cylinder engine. The compressor delivers 400 cu.ft. of air per minute against a pressure of 130 lb. per sq.in.; the air is used to operate Harris air-lift pumps in a deep well raising the water from a depth of approximately 167 ft. and delivering it to a storage tank. A twin-disk clutch inclosed in a housing bolted directly to the flywheel inclosure connects the engine shaft to the driving pulley.

The engine is the mechanical-injection Diesel type with cylinders of 6-in. bore and 8-in. stroke; it is rated at 92 hp. at its normal operating speed of 1,000 r.p.m.



Two-stage air compressor driven by high-speed Diesel engine

The actual brake horsepower load varies from 80 to 87 hp. This cylinder size is the only one built by the Buda Company at present, although it has imported a 50-hp. M.A.N. unit, which weighs but 1,100 lb., and is testing it on a truck.

Fuel with a gravity of 28 to 30 deg. Baumé is used, and is supplied from the storage tanks through a Niagara meter to a tank mounted on the engine-room wall. From the latter the fuel is fed to the injection pump on the engine by gravity, and a Zenith duplex filter is installed in the line to remove any foreign matter that may be in the fuel. Fuel is injected by the mechanical- or solid-injection system, which is under control of the built-in governor. The time of injection can be advanced or retarded manually, and the quantity of fuel regulated so that the speed of the engine can be controlled manually as well as by the governor. The fuel consumption ranges from 0.40 to 0.45 lb. per b.hp.-hr.

A small air-cooled two-cylinder opposed-type gasoline engine is mounted on the flywheel housing of the engine and is used for starting. This engine is connected by a conventional Bendix gear through a manually operated clutch and a short roller-chain drive. The Diesel starts with the same kind of fuel used for regular operation, and no compressor or preheating device is required.

This engine was installed several months ago for the purpose of observation and test and is operated by the regular power-house attendants.

Operating and Test Results With Unusual Furnace

In changing over from an old-style stoker to pulverized coal space limitations prescribed a diamond-shaped furnace in which were embodied several special features. How these have stood up in service is reflected in the low maintenance. Pulverizing data are included.

By GUY B. RANDALL

THE rejuvenation of old boiler plants often gives rise to problems more difficult and fully as interesting as those encountered when the engineer starts with a clean sheet of paper and a vacant lot. Moreover, the net result of the change is seldom in doubt because of the inevitable "before and after" comparisons. As an example of how one such problem has been worked out, reference may be made to Fig. 2, which shows an old 6,110-sq.ft. Stirling Boiler having a double V-type overfeed stoker and its established overhead and tunnel services for coal and ashes. Fig. 4 shows a unit pulverized-coal design developed by the writer and associates to replace that of Fig. 2, after consideration of a variety of standard underfeed stoker and pulverized-coal layouts and estimates.

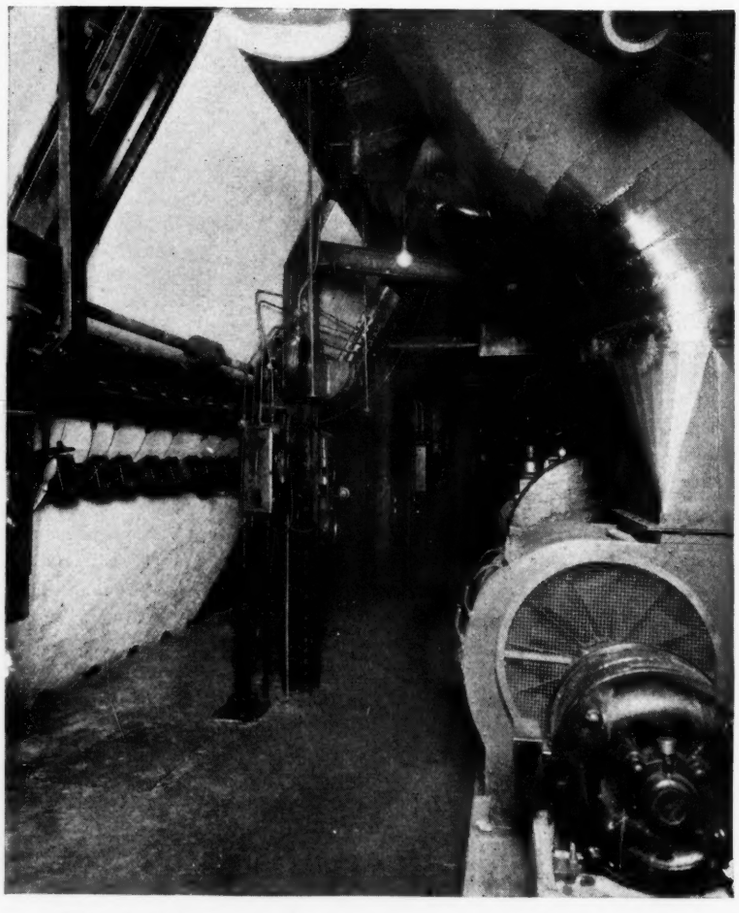


Fig. 1—View of boiler as changed for pulverized coal

The design adopted leaves the boiler in its original position with the rear half of the setting intact. It makes use of the same coal bunkers and ash tunnels and by an inclined front wall arrangement restores to the boiler-room aisle the space taken up by the unit pulverizer and the auxiliary air fan. The result is about 9 per cent net fuel saving and one-third more capacity. Sustained ratings of 300 per cent, though not in daily use, have been carried many times for several hours at a stretch without difficulty or damage. As compared with the old installation the new layout requires about one-half the boiler-room operating attendance and to date less than one-third the total maintenance expense. It enables the use of a lower grade of fuel at a net saving of 4 to 12 per cent, depending on the relative market conditions. Making conservative allowance for the increased boiler capacity available, the installation should pay for itself in four years even on a poor load factor.

The diamond shape of furnace was developed somewhat by force of necessity, but is believed to possess some merit of its own, particularly in connection with existing plants. The furnace is 15 ft. wide from side to side of the boiler, approximately 18½ ft. deep measured along the line of flame propagation, and approximately 12¼ ft. from the front bank of tubes to the front wall. It has a volume of 3,380 cu.ft., or 0.55 cu.ft. per square foot of original boiler heating surface.

The water-cooled bottom may be regarded as formed by taking a full front row of the boiler tubes and bending them sharply downward into a box header which is connected to the top front drum on one side only by an 8-in. downtake pipe. Two of the faces of the furnace

interior are water-cooled, two are air-cooled and two are solid. The side walls are of dry-pressed brick properly sized to lay up close and bonded with the Liptak interlock. Numerous expansion joints are provided in both vertical and horizontal directions for the inner course. The side walls are anchored by means of ½-in. steel rods to the main columns, which serve as fixed points in directing the expansion movements. The furnace is approximately 35 per cent water cooled (front boiler tubes and bottom).

The unit has been in operation over 1½ years without requiring furnace maintenance except for approximately $40, which should really be charged to experimental purposes. During this period an average rating of 200 per cent has been maintained, with daily peaks of several hours' duration at 240 per cent during the winter seasons. Inspection of the furnace at this time gives no prospect of any maintenance expenditure for an indefinite time to come. If the furnace should require relining, this will essentially be standard brick at $13 a ton rather than special tile at $40 or more. (For additional description of the water-cooled bottom, reference may be made to the writer's discussion in the A.S.M.E. proceedings for 1927, a partial abstract of which appeared on page 575 of *Power* for March 27, 1928.)

Experience with this bottom shows that water cooling with plain tubes of extra thickness is effective, comparatively cheap, may be applied to almost any surface and that pure water is not required. The cost of solid firebrick walls 22½ in. thick and of first-class construction is $3 to $4 per sq.ft. of surface. The more elaborate types of air-cooled walls complete with insulation have been running $7 to $9 per sq.ft. Water-cooled walls (or bottoms) installed with plain tubes and without frills run but little more in cost than the best air-cooled walls when all elements of the cost of the job are considered. In some cases the writer believes the water-cooled job may be of the lesser cost.

Experience with the various burners used on this installation proves that a great deal depends on proper burner action. The first burners caused severe flame impingement on the water-bottom and gave it a severe test. They also resulted in a 7 per cent unburned coal loss compared to a 1 to 2 per cent loss with the present burners. While a short flame may be secured if desired, the best efficiency is obtained by adjusting the flame length until it reaches well toward the bottom or even im-

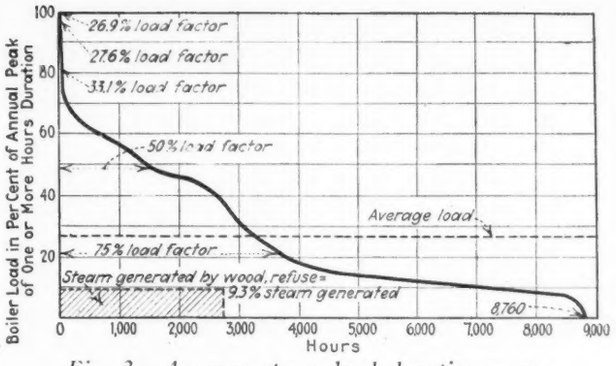


Fig. 3—Average steam load duration curve

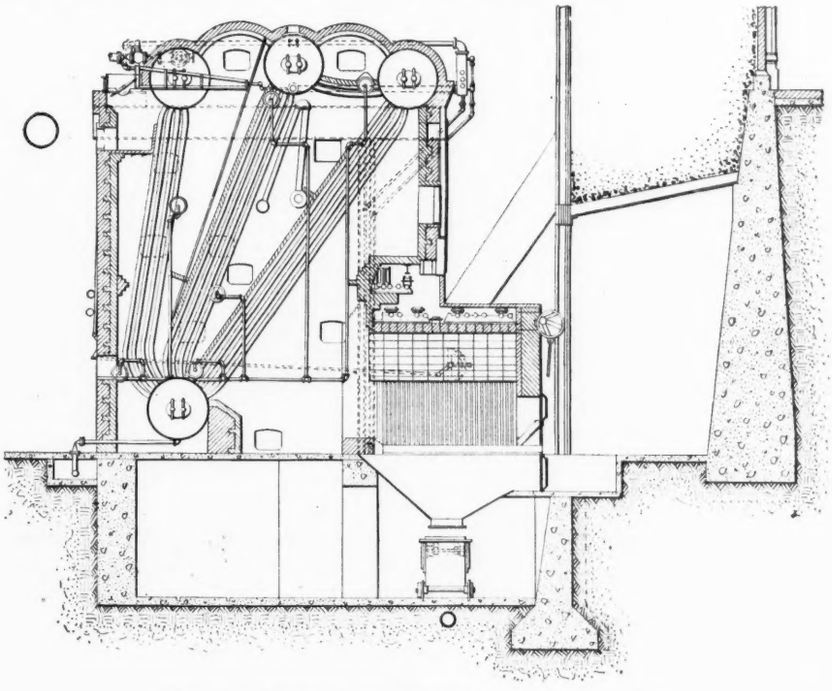


Fig. 2—Original setting with overfeed stoker

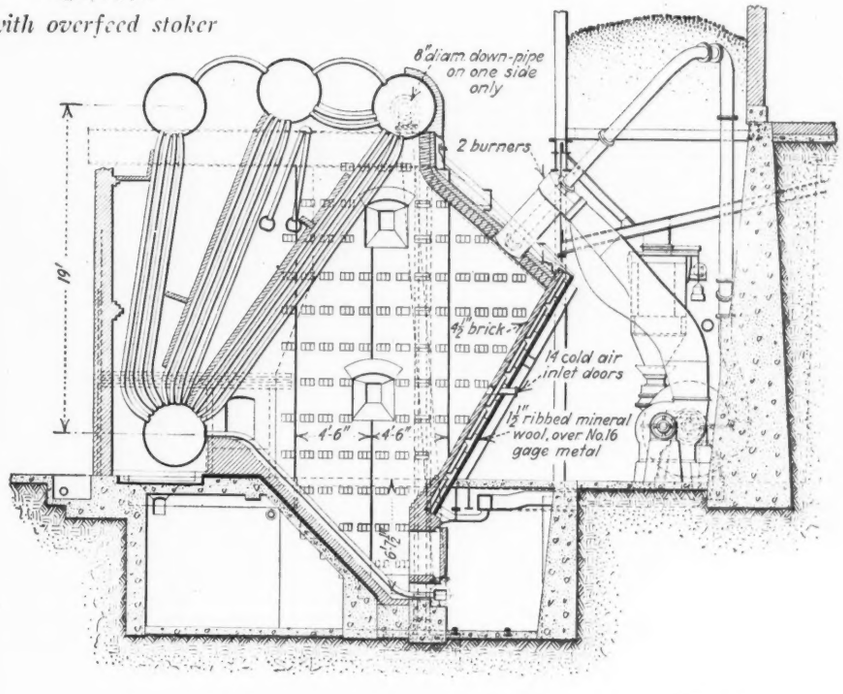


Fig. 4—Boiler setting shown in Fig. 2 after remodeling for unit pulverizer and two burners

pinges lightly thereon. In this way the bottom is kept from being too cold to get the full benefit of its heat-absorbing surface.

What may be termed the characteristic curves of this type of unit pulverizer (the Atrita) are shown in Fig. 8. These represent the variations in fineness of the coal and in the power requirements when using Harlan, (East) Kentucky, or Logan County, West Virginia, coals, both being rather difficult to pulverize. The nominal rating of the unit by the manufacturer is 5,000 lb. an hour, but the curves are carried out well beyond this capacity.

With little trouble the internal arrangement of the machine may be modified to give considerable changes in the characteristics. For example, the fineness-capacity curve may be made flatter or steeper than is here shown. One can almost say the fineness-capacity line may be rotated about the 3,500-lb. point. Of course this brings corresponding changes in the power-capacity curve.

The life of a set of moving pegs was found to be approximately 6,000 tons of coal, and the variation in fineness of the coal from new to old pegs is generally not more than seven or eight points on the 200-mesh Tyler screen. Fig. 9 shows the uniformity of the wear of the pegs in proportion to the tons of coal pulverized to approximately 70 per cent through 200-mesh Tyler screen, and 99.9 per cent through 28-mesh. In all cases coal fineness is referred to the condition of sampling near the pulverizer outlet by traversing the pipe in fourteen positions, half of them being at right angles to the remainder, with a suction on the sam-

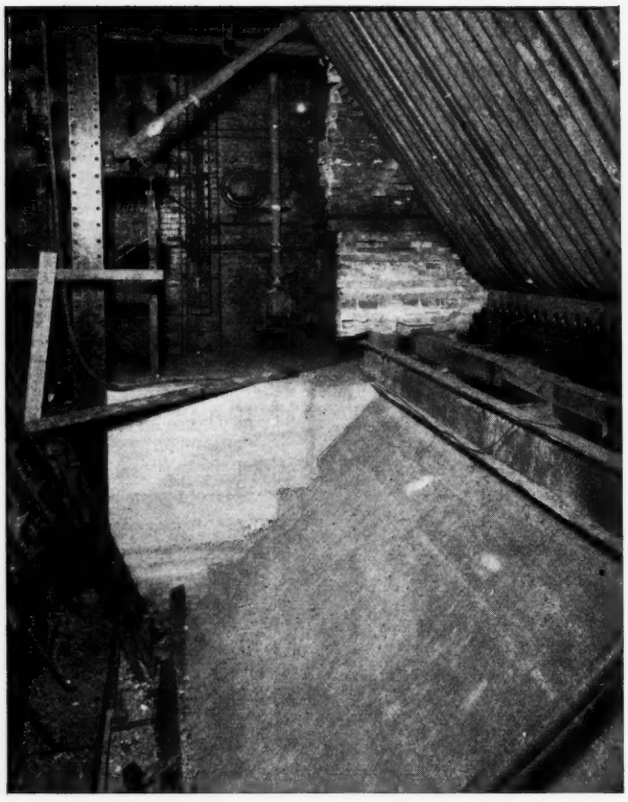


Fig. 5—Construction view showing tube holes trepanned between front tube bank and longitudinal seam

Fig. 6—Interior of furnace after burning over 14,000 tons of coal with furnace maintenance under 3 mills per ton

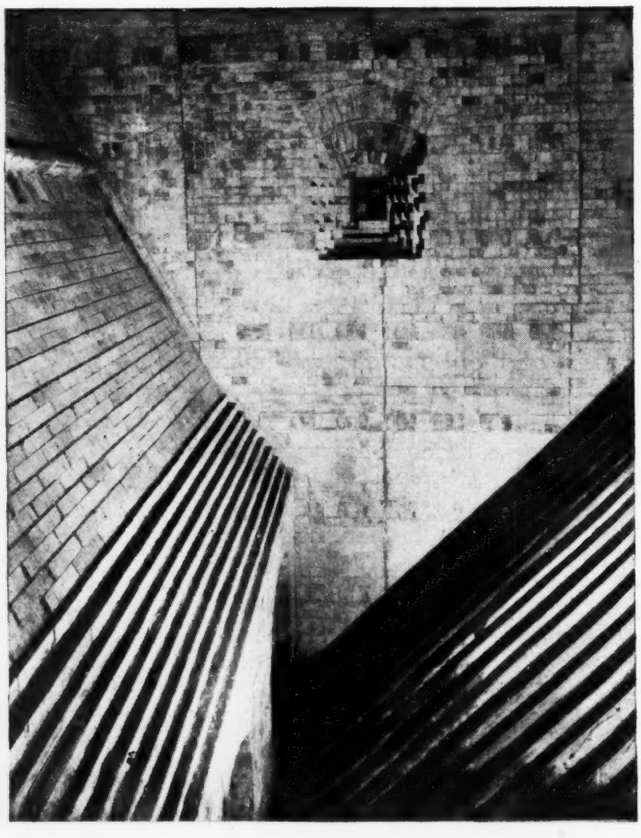


Fig. 7—View of "V" shaped bottom of furnace for collecting ashes, also water screen of 3¼-in. tubes

pling tube to give the normal velocity of the air flowing in the main pipe.

The actual maintenance cost of the pulverizer as now installed is 4.6c. per ton of coal, including labor, with repair parts averaging about 15 cents per lb. In any pulverized-coal installation the interlocking relationship

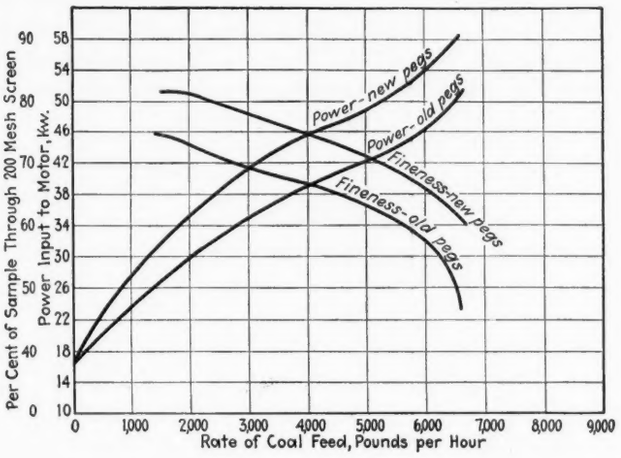

Per Cent of Sample Through 200 Mesh Screen
Power Input to Motor, kw.
Power—new pegs
Power—old pegs
Fineness—new pegs
Fineness—old pegs
Rate of Coal Feed, Pounds per Hour

Fig. 8—Characteristics of unit pulverizer

of the kind of coal, the fineness, the capacity, the wetness of the coal and the power required is not lightly to be dealt with.

In the writer's experience some coals require twice as much power to pulverize to a given condition as others. Hence, the friability factor is approximately 2. The heat value of the coal may vary 50 per cent and thus give a heat factor of 2. Some screenings may carry 15 per cent surface moisture and reduce the pulverizer capacity about 50 per cent from its maximum. Hence, there may be a moisture factor of 2. So for a given pulverizer

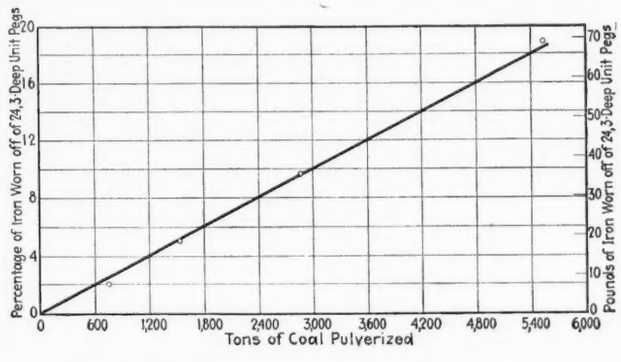


Fig. 9—Rate at which moving pegs are worn. Note the uniformity against coal tonnage

the power requirements may vary by $2 \times 2 \times 2 =$ 8-fold and the maximum output of the unit in heat units by over $2 \times 2 = 4$-fold. These large variations represent extreme conditions, but serve to emphasize that the pulverizer should, in the present state of the art, be fitted with considerable care to the particular job and its environment.

While the most usual operation of this pulverizer is in the neighborhood of 4,000 to 4,500 lb. of coal per hour, it also frequently operates at outputs as low as 1,000 lb. on Sundays in the summertime. Only one burner is used with the pulverizer at ratings below 130 per cent. To meet any given load condition, two adjustments are usually made on the pulverizer itself—one to govern the coal feed and the other the carrier air which transports the coal through the machine. But the latter adjustment is important only when the load change or the change in pulveribility of the coal is considerable. The secondary fan which furnishes the bulk of the air for combustion is provided with a four-speed alternating-current motor. This arrangement costs little extra, gives four points of maximum efficiency and takes a minimum of power. It is particularly good where boilers have to be operated over a wide range of load. Moreover, it enables high fan speeds and velocities to

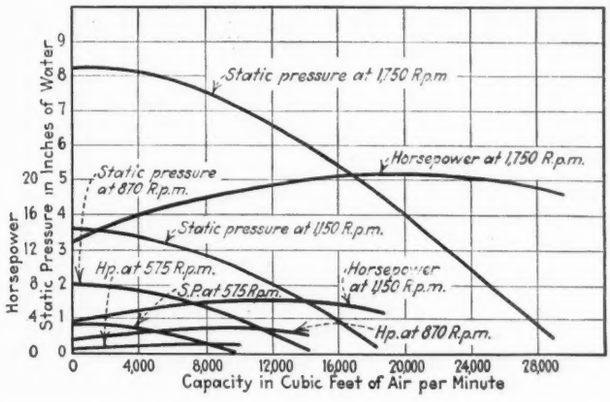

Horsepower
Static Pressure in Inches of Water
Static pressure at 1,750 R.p.m.
Horsepower at 1,750 R.p.m.
Static pressure at 870 R.p.m.
Static pressure at 1,150 R.p.m.
Hp. at 575 R.p.m.
S.P. at 575 R.p.m.
Horsepower at 1,150 R.p.m.
Hp. at 870 R.p.m.
Capacity in Cubic Feet of Air per Minute

Fig. 10—Four-speed secondary-air fan characteristics

be used for peak ratings, and this results in a smaller fan and piping. Fig. 10 gives these characteristics. For operation from about 50 to 100 per cent rating the lowest speed is used, in the range from 100 to 175 per cent the second speed is used, and the third from 175 to 250 per cent. The fourth, or highest, speed is available for still higher ratings up to the limit of the natural draft to remove the gases, which in this case is about 300 per cent.

Arrangements were early made to get fairly complete

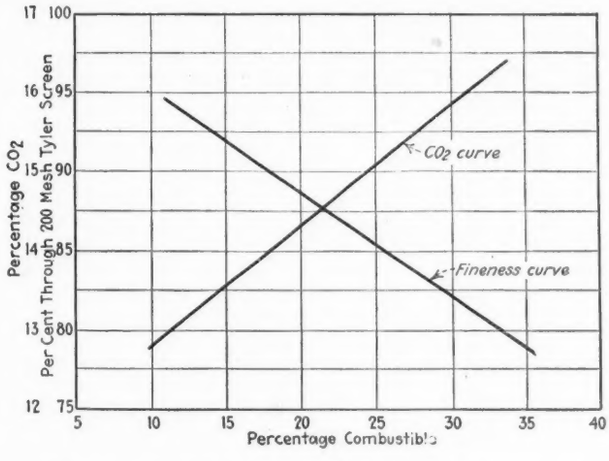


Fig. 11—Variation of combustible and fineness of refuse in boiler uptake gases

test data. Automatic coal scales and tanks for accurately weighing feed water were provided. Flue-gas temperature determinations were made by the potentiometer and thermocouple method, and three Orsat samples were taken continuously at both the second pass and at the third pass gas outlets, in addition to the regular CO_2

recorder. All elements of the boiler meter were also carefully calibrated and used. A great many tests have been made in studying various aspects of the installation, and while not the best and most satisfactory test obtained, that given in the table is believed to be fairly representative.

The unit can be brought up from practically cold to 200 per cent rating in approximately half an hour. Since 90 to 95 per cent of the unburned coal loss floats out of the stack and the loss increases with the heat liberation rate in the furnace when other conditions are equal, it becomes desirable to know about what it is and how it varies. The table gives some information on this under the heading of refuse. Fig. 11 shows how the percentage of combustible in the uptake gases varies with the CO_2 for a particular rating; also, the relation between the size of this combustible dust and the carbon in it.

With pulverized coal the old question of measuring the CO drops out of the equation. There is no CO to measure unless combustion conditions are such that the flame is dull and opaque like a fog. In the writer's experience, if the unburned carbon loss is handled properly, the CO loss can be left to take care of itself.

The ash fusion point of Logan County and Harlan coals runs about 2,500 deg. F., being about 2,600 deg. F. for the particular sources tested. On this coal, as used in the test recorded in the table, ratings of 300 per cent can be carried without trouble. However, when using Pittsburgh No. 8 coal with a fusion point of 2,200 deg. F., slag adheres to the front bank of tubes at ratings above 235 per cent unless the CO_2 is dropped. Hence the writer feels that for burning this coal the front wall and the arch should also be water cooled. This can be readily done at little increased cost. It will be noticed that the diamond furnace lends itself inexpensively and readily to water cooling for all except the two side walls, which may preferably be used for getting hot air for the pulverizer instead of using the front wall and part of the arch, as in this case. It has been hoped to try out some Illinois or Indiana coals for comparison purposes, as the writer feels that, owing to the high inherent moisture, these coals might not be so hard to handle in comparison with Eastern bituminous as is popularly supposed. These coals, as well as sub-bituminous and lignite, air-slack on drying. It seems possible, therefore, that what may be termed the "pop-corn" effect of the inherent moisture may offset some of the disadvantages in pulverizing and burning them.

RESULTS OF TEST ON BOILER NO. 14

Date of test	1928—March 1
Duration, hours	8
Per cent of rating	202
COAL AS FIRED	
Through 28 mesh, per cent	99.92
Through 100 mesh, per cent	92.24
Through 200 mesh, per cent	70.35
Moisture, per cent	2.30
Fired per hour, pounds	3,882
ULT. ANALYSIS, DRY BASIS, PER CENT	
Carbon	77.60
Hydrogen	5.37
Oxygen	8.08
Nitrogen	1.30
Sulphur	1.10
Ash	6.55
PROX. ANALYSIS, DRY BASIS, PER CENT	
Moisture	0.00
Volatile	35.08
Fixed carbon	58.37
Ash	6.55
B.t.u. dry, per pound	14,039
WATER, POUNDS	
Evap. per lb. of coal as fired	10.05
Equivalent evap. per lb. of dry coal	11.26
B.t.u. per lb. of steam	1,060.4
TEMP., DEG. FAHR.	
Wet bulb	65.4
Air to furnace	88.2
Air to pulverizer	204
Gases leaving boiler	596
Water to boiler	210
Superheated steam	442
Superheat	72
Press. at superheater outlet, lb., gage	158
DRAFTS, IN. OF WATER	
Furnace	0.03
Leaving boiler	0.26
Secondary fan at outlet (press)	2.80
Pulverizer fan, suction	.....
Pulverizer fan, discharge	.....
Pulverizer, air intake pipe	0.25
GAS ANALYSIS, PER CENT	
CO_2 leaving boiler (Cor. to 25% excess air)	14.4
CO_2 leaving boiler	4.5
CO leaving boiler	0.0
CO_2 leaving second pass	.....
CO_2 leaving second pass	.....
CO leaving second pass	.....
CO_2 plus C_2 plus CO	.....
REFUSE	
From furnace, per hr., lb	29
Comb. in furnace refuse, per cent	1.5
From third pass, per hr., lb	10
Comb. in third pass refuse, per cent	30
Comb. in uptake gases	20
Refuse in uptake gases, lb. per hr	268
Weighed average combustible	18.7
Total weight of solid refuse incl. stack dis., lb. per hr	307
HEAT ACCOUNT IN PER CENT	
Heat absorbed by boiler, superheater & water bottoms	77.80
Loss in dry gases	11.75
Loss due to moisture in coal	0.21
Loss due to moisture from H_2	4.41
Loss due to moisture in air	0.16
Loss due to incomplete comb. of carbon	0.00
Loss due to unconsumed carbon in ash	1.57
Radiation and unaccounted for	4.10
Total	100.00
PULVERIZER UNIT	
Feed table opening, inches	2.63
Butterfly damper opening, inches	2.30
FURNACE AND MISCELLANEOUS	
B.t.u. per cu.ft. per hr. (Cor. for unburned coal)	15,500
Fan speed in r.p.m. synch	1,200
POWER IN KILOWATTS	
Av. total power during test	49.0*
Kw.-hr. per ton of coal fired	25.2

NOTE—No. 14 boiler is a Class N-30, Stirling, 6110 sq.ft. heating surface, 4 rows 3¼ in. tubes in each of three passes. The superheater has 651 sq.ft. of surface (based on 4/1 ratio of corrugated C.I. surface to cylinder surface of 2 in. O.D. tubes. 31 elements.)

Water bottom contains 470 sq.ft. of 3 in. tube surface with standard Stirling spacing averaging 6 in. center to center.

Total heating surface = 7231 sq.ft.

Projected area of front tube bank = 300 sq.ft.

Projected area of water bottom = 195 sq ft.

Total projected area = 495 sq.ft.

Total cu.ft. of furnace volume is 3,380 (15 ft. wide, 12¼ ft. deep, 18½ ft. high).

35 per cent of furnace interior is water-cooled.

Unit pulverizer size No. 4 Riley three deep moving pegs, magnetic separator, and 60-hp. 1150 R.M.P. motor.

This test was with Cardinal mine coal from Harlan field, Bell county, Eastern Kentucky.

*43.7 kw. for pulverizer plus 5.3 for fan = 49.0 kw. total (2.7 kw.-hr. per ton of coal for secondary air fan only).

Detroit—City of Power

Detroit, scene of the coming N.A. P.E. Convention, is a fitting spot for such a meeting. Power, in its various forms, is the keystone of Detroit's industrial position—power in the automobiles that swarm over America's roads and power in the factories that build them. In recognition of this intimate relation a pictorial section showing power equipment in Detroit industries will be included among the many special features of the September 4 issue.

Oil Circuit-Breaker Inspection and Maintenance

By R. B. Greenwood

> Oil circuit-breakers may not be required to function under short-circuit conditions for long periods. Unless they are carefully inspected and the oil, contacts and operating mechanism maintained in good working condition, they may fail in an emergency with disastrous results.

HEAVY-DUTY oil circuit breakers are usually installed in cells. Circuit-breaker cells should be well ventilated, amply large to facilitate maintenance work, and of sufficient strength to withstand shocks arising during operation. Permanent hooks should be provided for lifting. Cells should be arranged so that workmen employed on a breaker that is out of service will not be injured because of the operation of an adjacent breaker.

Modern safety devices and provision for blocking and grounding should be included in switch-cell design. Circuit-breaker frames should be grounded by means of conductors large enough to withstand the maximum ground current that will probably flow during faults. For appearance and cleanliness circuit-breaker cells should be kept painted, using a dark color around the tanks and for the floor and white on the upper and exposed walls.

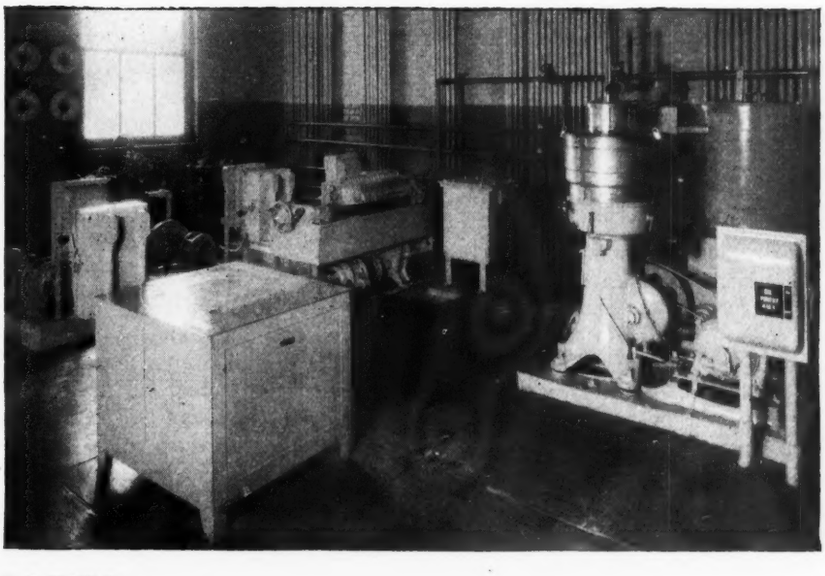
After unpacking a circuit breaker should be carefully cleaned, inspected, and all adjustments checked in accordance with the manufacturer's instruction book, a copy of which is usually packed with each breaker. Adjustments may be altered during shipment. All wooden blocking should be removed, and all contact surfaces should be particularly well cleaned, using fine emery cloth. The tanks and their insulating liners should be cleaned and inspected. A check should be made on the circuit breaker's insulation resistance before connections are made. Initial operation should be by means of the operating lever, not electrically until the breaker is found to close and open properly. It is important that the circuit breaker be properly cushioned during opening and closing.

Particular care must be taken to see that the conductors terminating at the circuit breakers' terminals are of sufficient capacity and so connected that heating will not result during normal overloads, nor failure occur while short-circuit current is flowing.

As an example, one type of 1,200-ampere circuit breaker is designed with sufficient thermal capacity to carry 60,000 amperes for five seconds. Obviously, if the conductors connected to the terminals of this breaker cannot withstand at least as much heat as the breaker parts, results are likely to be disastrous.

Conductors should be well supported and braced, and the circuit-breaker terminals should not be used as conductor supports. For facilitating inspection and repair work, circuit-breaker terminal connections should generally be left bare, but it is better to apply considerable tape rather than risk a flashover. In order to hold maintenance charges at a reasonable value, it should be possible, where a number of circuit breakers are installed, to fill or empty any tank by making short hose connections. This means that a system of oil piping should be installed, and in some cases a central oil-treating outfit would be required. Usually, an oil-treating outfit, together with the necessary storage tanks is available, hence the circuit-breaker piping system alone is all that would be needed.

Fig. 1—Central treating plant for insulating oil contains centrifugal purifier and filter press



Reliable circuit-breaker operation can hardly be expected unless clean, dry insulating oil is used. Oil testing at least 28,000 volts with the standard gap should be put in the tanks. Circuit-breaker oil should be actually tested for puncture, the heating and hot-nail methods being too unreliable.

Circuit breakers formerly required an oil somewhat different from that used in transformers. Oils are now available that are equally suitable for transformers and

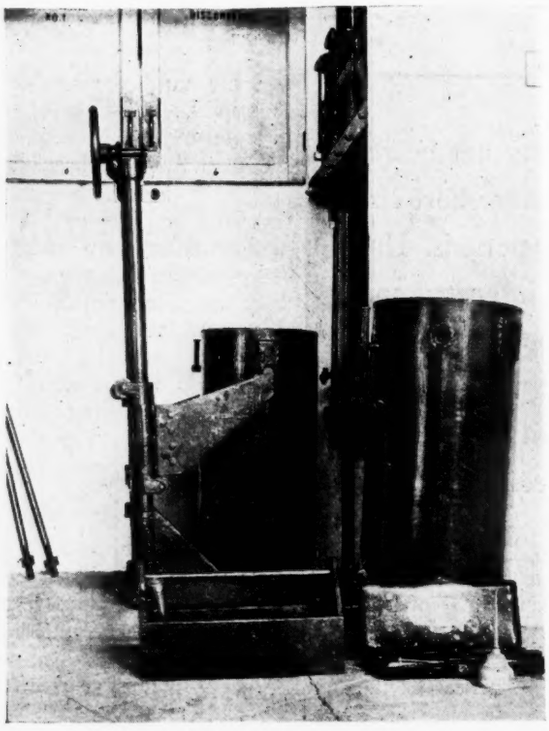


Fig. 2—Oil tanks being removed with tank lifter

circuit breakers. One oil should not be mixed with another without the approval of the manufacturer.

Keep the oil level at the height marked on the gage. Under ordinary conditions oil need be added only infrequently. Oil may be expelled when the circuit breaker opens a short circuit or disconnects a generator that is out of step. When the rupturing capacity of the circuit breaker is approached, the cell doors may be thrown off by the gases that are expelled from the tanks.

Only clean, dry oil should be added, and the usual method is to pump it into the tank through the drain cock, preferably while the circuit breaker is out of service, by means of a small rotary pump or by using the oil filter set. A pipe plug to which Bakelite or shellac has been applied should be screwed into the end of the cock to prevent leakage, as cocks do not usually remain oil tight.

Oil in indoor circuit breakers is not likely to absorb much moisture, yet the oil should be tested for dielectric strength at intervals of six months, and the results recorded and filed. When the breakdown voltage becomes 22 kv., the oil should be drained out and replaced with oil testing 28 to 30 kv. The insulating qualities of the old oil can be restored by passing through a centrifugal purifier or a blotter filter press.

Each time current is ruptured by a circuit breaker, carbon is formed in the oil, the amount depending on the magnitude of the current broken. Considerable carbon will accumulate in the oil of a circuit breaker that is opened frequently, therefore carbon should be looked for at intervals of six months.

Visual inspection of the oil samples drawn for the breakdown test will disclose the presence of carbon, but a better method is to drop the tanks and note the amount of carbon deposited on the contacts. At this time the internal parts should be inspected.

Dark, dry oil containing considerable carbon will probably withstand 28 to 30 kv. across a 0.1-in. gap, yet because the carbon will adhere to insulating surfaces, thus reducing the insulation resistance of the bushings and strain rods, oil must be purified when an appreciable amount of carbon is found.

Very black carbonized oil can be made satisfactory for circuit breaker use by passing through a filter press until clean. Blotters become more efficient for removing carbon after their pores become partly clogged, but this decreases the capacity of the filter. Very bad oil may require chemical treatment.

After drawing off carbonized and fouled oil, clean the tanks and all internal parts with clean switch oil or gasoline before refilling.

Maintenance of Contacts

It is advisable to feel the tanks daily to detect possible heating. If the tanks overheat, check the load current and inspect the circuit breaker's external connections before assuming that the fault lies within the tanks. If the temperature rise is excessive and is found

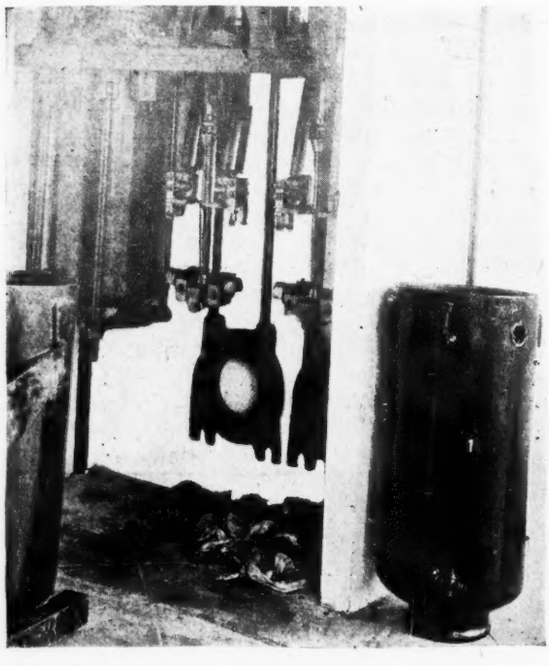


Fig. 3—Oil tanks removed for inspection and adjustment of switch contacts

to be due to the circuit breaker, the tanks should be lowered and the contacts cleaned and adjusted.

While the maximum temperature of a circuit breaker is limited to 70 deg. C., the operating temperatures of most circuit breakers will not exceed 30 to 40 deg. A tank at a temperature of 50 deg. feels very hot to the hand. The cause of any unusual temperature rise should be located as soon as practicable.

The movable contacts can be adjusted by screwing

the strain rod on or off the threaded end of the steel lifting rod. The threads on the contact rods allow for vertical adjustment of the stationary feet. When the circuit breaker is latched in the closed position, the movable main contacts of all phases must make positive and uniform contact with the stationary surfaces.

The area of contact surface can be seen by rubbing a piece of carbon paper on the movable contact faces and closing the circuit breaker to obtain an impression. Upon opening, the effective contact area will be imprinted on the surfaces of the stationary main contacts.

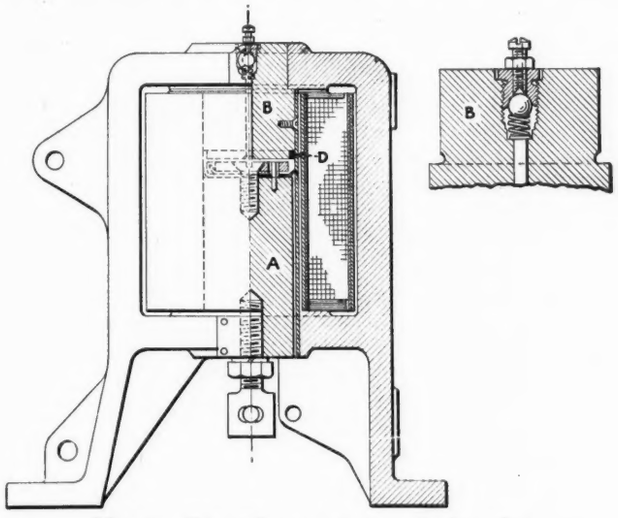


Fig. 4—Operating magnet and air valve

Even with good imprints a circuit breaker will run warm unless contact is made under considerable pressure.

The arcing contacts are provided to protect the main contacts from burning and are not depended on to carry current. However, it has been found that the tank temperature will be reduced by dressing badly burned arcing contacts.

Removing the Tanks

On large oil circuit breakers the tanks are usually handled by means of a truck-type tank lifter. This lifter will effectively support the tank, and it permits of quick removal and replacement. Care must be taken to see that the oil gage is not damaged and to pull the tank up squarely against the packing inserted in the groove in the circuit-breaker base, when the tank is being replaced.

Opening and Closing Coils

If the circuit breaker is intelligently operated, the trip and closing magnet coils should last for years. These coils are not designed for continuous duty and will soon be damaged if left in circuit any length of time. The closing-coil current initially may be sufficient to weld together the contacts of the control relay unless considerable pressure is applied. The control-relay coil closes these contacts with ample pressure to prevent welding, but welding has resulted when the control-relay contacts have been closed by hand. Unless soon detected, the closing magnet coil will soon be burned out should the control-relay contacts remain closed. Should a closing magnet coil become overheated due to being left in circuit, it should be tested when cold to determine if damage has actually resulted.

If the circuit breaker closes too violently, not only is the entire mechanism subjected to unnecessary shock, but the tank bushings will become loosened in their brass collars. To prevent violent opening, the moving core of the operating magnet is designed, on some types, to compress air in the closing direction.

In Fig. 4 the upper end of the moving core *A* is provided with a cup leather. The stationary core *B* is made airtight with $\frac{1}{4}$-in. square flax packing as shown at *D*. As the moving core is drawn upward in its brass sleeve, air is compressed against the spring check valve, shown enlarged, at the right. If the screw is backed out so that the brass ball can seat, no air can escape, and a maximum cushioning effect is secured. The adjusting screw is hollow, and air escapes through it if the ball is prevented from seating. To function properly the packing of the operating magnet must be kept tight and the cup leather must be kept soft by applying two or three drops of neatsfoot oil monthly through the check valve. To avoid disturbing the adjustment of the check valve, a separate hole, normally closed by a screw, may be drilled to the ball chamber.

It is necessary to lift the complete operating magnet to replace the core cup leather or packing. It is not an easy matter to repack the stationary core, and in some cases freedom from possible air leakage has been obtained by brazing this core to the brass sleeve.

A check on the amount of dashpot leakage can be made by admitting compressed air to the dashpot through a fitting temporarily replacing the check valve in the end of the core. If the dashpot is in good condition, there should be very little leakage.

Fig. 5 shows one method of easily starting the movable core into its brass sleeve. The piston leather follower is slipped over the core, thus compressing the cup leather. The follower is then placed against the end of the brass sleeve and the core inserted.

At monthly intervals the circuit breaker mechanism should be thoroughly blown out with compressed air. Accessible bolts, nuts and cotter keys should be checked and all moving parts lightly lubricated with engine oil.

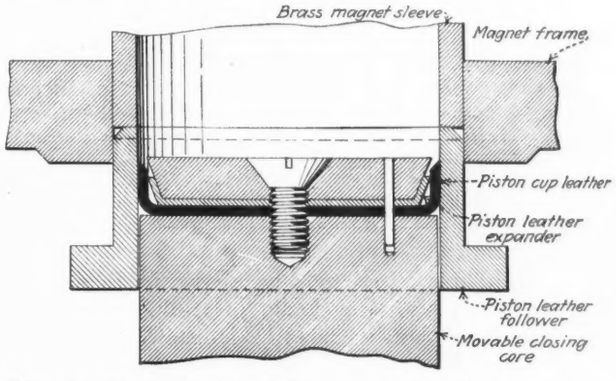


Fig. 5—Piston-leather follower used to insert magnet core into brass sleeve

The control wiring connections should be checked for tightness during this monthly inspection. With a competent observer at the circuit breaker, it should be opened and closed once or twice from the switchboard to determine if the mechanism is in good order.

A circuit breaker should be properly blocked either in the open or closed position, depending on the nature of the work to be done, before undertaking repairs. If the work is to be done on the contacts or terminals, the circuit breaker should be grounded.

For circuit breakers subject to ordinary service the following maintenance schedule is suitable:

At monthly intervals clean and lubricate the operating mechanism; observe the breaker's operation and correct any defects found; restore the oil level if low, examine contacts of full-automatic and control relays, and see that all connections are tight.

At six-months' intervals and after opening excessive current, make an inspection the same as the monthly program, but in addition the tanks should be lowered and all internal parts inspected and repaired if necessary. Check the backlash in the operating mechanism. The oil should be tested and changed if badly carbonized or if breakdown occurs at less than 22 kilovolts.

A yearly inspection, the same as bi-yearly, should be made, but more detailed. In particular, worn parts are to be replaced at this time.

To schedule future maintenance work intelligently and to obtain accurate knowledge of circuit-breaker performance, repairs and inspections should be recorded in permanent form.

The number of spare circuit-breaker parts that should be kept on hand depends on so many factors that general rules cannot apply. If the maintenance work is done by skilled men and machine-shop facilities are available, spare contacts, strain rods and cup leathers are about all that is needed. In isolated localities where shop facilities are not readily available, a large stock of spare parts is justified.

All circuit-breaker parts can be selected from a part catalog issued by the manufacturer. Spare parts should be properly stored and clearly identified by cloth shipping tags or otherwise.

Some Causes and Cures of Flat Spots on Slip Rings

By W. E. Warner

SLIP RINGS on alternators and converting equipment are subject to wear and running troubles, which can be overcome only by systematic inspection and cleaning. The rings and brush-holders should be cleaned weekly, to remove any dust that may collect and cause a current creepage between rings and lead to a short circuit. A good surface should be maintained on the rings by means of a hand-stone or sandpaper block. A rough ring surface increases the wear and tear on the brushes. This is particularly so with metal-graphite brushes, which deteriorate rapidly if sparking occurs. These brushes have a high inertia and may be unable to follow the ring surface if this is much out of truth.

Metal-graphite brushes have the advantage of a low voltage drop through them and are capable of withstanding considerable overloads. They give excellent service provided the ring surface is smooth and true.

The spring tension on the brushes should be that recommended by the machine builders. Usually, about two pounds per square inch of contact surface is sufficient, but if the rotor is improperly balanced, the tension may have to be increased to keep the brushes in contact with the ring. The brushes must be free to move in their holders, for if they are not they will bind and cause flat spots on the rings.

The brush should just cover the width of the ring without overhanging on either side. When a brush overhangs a ring, a thin edge will form at the point of overhang, which will, if the rotor oscillates a little more than normal at any time, tend to lift the brush and cause sparking. The edge is also likely to break off and cause other trouble. The wear on slip rings is variable. On one machine there may be considerable wear and trouble, while another similar machine may be practically trouble free.

On alternators the positive ring usually develops a discolored appearance, while the negative ring retains a bright surface. The wear on the negative ring is greater than on the positive ring. On the negative ring the bright surface is due to the metal of the ring being deposited on the brush, while the discolored surface of the positive ring is due to the carbon from the brush being deposited on the ring.

In some stations it is the practice to interchange the connections to the brushes on the rings periodically, making the positive negative and vice versa, to equalize the wear. The wear of slip rings is due to three causes: Mechanical abrasion, a burning action, and what appears to be an electrolytic effect. The wear due to mechanical abrasion is uniform. It depends on the type of brushes used and the pressure with which they bear on the ring, and also on the metal of which the ring is made. The burning action is caused by the heating effect of the current as it passes between the slip ring and brushes. In alternating-current rings the current is not uniform, as it is continually changing in value and direction. The wear is largely dependent on the efficiency of the current collection, and can be kept within proper limits by using a sufficient number of well-fitted brushes.

Wear due to the electrolytic effect is caused by the transference of metal from the ring surface to the brush surface in the direction of current flow. With alternating-current this wear occurs during the half-cycle, only when the current flows from the ring to the brush. This may lead to the formation of flats, especially if the number of brushes is small.

Flat spots are also caused by polarity effect. This is peculiar to the collection of alternating currents, when the instantaneous value of the current between the brush and the slip ring occurs continuously at some point or points on the ring during each revolution. As many flat spots may be formed as there are poles in the machine, owing to this effect. The tendency to form flat spots is always greater when only one or a small number of brushes are used. With a larger number of brushes distributed around the ring this tendency is reduced.

Where trouble due to flat spots has occurred, a successful remedy has been to increase the number of sets of brushes used around the rings. Although an insufficient number of brushes may be the cause of continual formation of flat spots, poorly fitted, stuck or improperly adjusted brushes and current surges may also cause this trouble.

Do You Know That

Synchronous motors are used in 166 applications in fifty industries? Read about these developments in the next issue and see where your own industry fits into the picture.

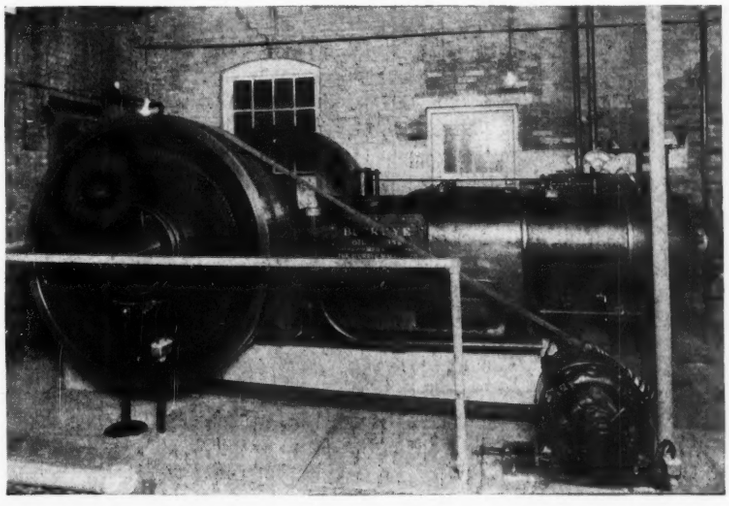
THE SMOKING CAR *Discusses*

The Oil Engine

By John Cassiday

THE three of us had been sitting in the Pullman smoking room while the train covered more than 100 miles through Ohio. Joseph P. Smith sold adding machines, with which fact he made us acquainted before the train pulled out of Cleveland. I confess it didn't take much urging before he was aware that I sold hardware. What the third man did for a living all of Smith's inquisitive conversation failed to reveal. Finally, Joe gave it up and started on his long tale of the difficulties of selling adding machines. With that off his chest, he sprung a list of jokes, some of which were new.

All this time the third man said no word, and if Joe needed the encouragement of all his listeners, he would have been forced into silence. Finally, the stock of jokes was exhausted and Joe was hard pressed for a subject. Frankly, I was much better as a listener than as an after-dinner speaker, so Joe felt called upon to carry the burden, for the smoking room is primarily a conversation room.



The 190-hp. Buckeye oil engine installed by the Franklin Manufacturing Company

As Joe cast about for a subject, the train slowed down to pass through a small village. Bending down to see better the sign on a shut down factory, Joe exclaimed, "That is the fifth busted office furniture mill we have passed this afternoon."

True, I knew nothing of office furniture, but, "Why," I asked, "do they fail? Making and selling desks and filing cases is quite a commonplace job. Why, anyone with a glue pot and jointer can make a desk."

"Search me," answered Joe. "Desks are desks and there is always a demand. For in the words of the prophet, 'a sucker goes into business each second of the year and two go out during the same instant.' "

"Now," continued Smith, warming up, "selling adding machines is different. You spend a whale of a time in convincing a prospect he needs an adding machine. On the other hand the poor dub knows he must have a desk and a chair, or where would he sit while waiting for his first customers to show up? Desk factories fail simply because one out of five business houses must fail each year to make our statistics correct."

"I grant you," interrupted the third passenger, who we subsequently learned was named Beck, connected with the Franklin Manufacturing Company, "that the making of a desk is easy, but selling it—that is a different story."

"Of course," he continued, in spite of Smith's protests that he had been misunderstood, "it is easy to sell office desks, but it is not easy to sell them and make a profit. Just why that factory you just passed is shut down I do not know; probably because the management forgot that a profit was necessary, or if they did remember it they probably found they couldn't sell at the market price and make a profit, with manufacturing costs as they are.

"It is true that in any kind of industry the real minimum selling price in any competitive market is based on the lowest possible cost of production. The man who cannot reduce his manufacturing costs to that of his lowest competitor will either use up his surplus or go out of business.

"It happens that I am in the office furniture business," Mr. Beck continued with a smile. "In fifteen years I've prospered, but in recent years competition has been so keen that we have been forced to cut out waste in every department."

"I suppose your biggest saving was in buying lumber cheaper," ventured J.

"No, for we had always purchased very carefully. Our greatest saving was in reducing the cost of power. We were purchasing electricity at an average rate of 2.033 cents per kilowatt-hour. This seemed high, and after due investigation we installed an oil engine. This cut the cost in half, even when the overhead charges were included. The fuel oil costs us 4.5 cents a gallon and the maintenance is very low."

"But why buy an oil engine," Smith wanted to know. I afterward learned that, although he was selling adding machines, he had studied mechanical engineering and thought a steam engine the last word in machinery. "You must use steam for lumber driers."

"We do use some steam for drying, and for this we operate a 1,000-sq.ft. boiler. But we cannot use low-pressure steam, so could not avail ourselves of exhaust

steam from a steam engine. It was this fact that made the oil engine installation possible."

"But what do you do with the wood scrap and shavings," I asked.

"This refuse is just about enough to supply steam to the driers."

"But is the oil engine reliable? How about breakdowns? Even my old college professor used to shake his head over the troubles of a gas engine."

"That was the point raised by those who argued for purchased current. We investigated a hundred or more plants, and in all of them the service was more reliable than our electric energy. Incidentally, the man who fires the boiler tends the engine, so engine-labor costs do not exist."

"Frankly," Mr. Beck continued, "Buying the 190-hp. oil engine reduced our manufacturing costs, which permitted a slight reduction in selling prices, which in turn brought more business. Increased production caused another reduction and more profit."

"Why don't more factories put in these new plants then," Joe wanted to know.

"Probably because a lot of managers want to shirk as much work as possible. They would rather put the responsibility of producing power on someone else, even though it means a financial disaster.

"We found that our duties were not increased by the installation of the engine. True, we do have the responsibility of seeing that our power is available at all times, but this is small compared to our former worries whenever a good sleet storm occurred even though the transmission lines never did go out."

"Seems as if selling oil engines ought to be easy," Smith opined.

"It would be if factory managers knew how to think," Mr. Beck threw back, as he rose and left the smoking room. Joe for once had no rejoinder to make.

A Check on the Smoke Stack

THERE is an intensive drive against the smoking chimney in many cities and towns. Some of the progressive communities have enacted ordinances wherein a penalty is assessed against the engineer or owners of boiler plants found guilty of having a chimney emit smoke.

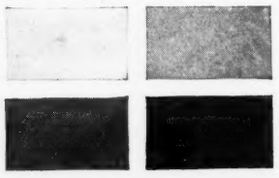


Fig. 1—The four Ringelman shades

Of course it is impossible to prevent a slight amount of haze above the stack, so it is usual to specify that the smoke shall not exceed No. 2 Ringelman. But the engineer may ask: What is No. 2 Ringelman?

The Ringelman Chart, reproduced in Fig. 2, is made up of four sets of gratings. By placing this chart at a distance of about 25 ft., these gratings appear to become solid, of a color ranging from a light gray to a dense black, as shown approximately in Fig. 1.

This chart enables the engineer to check the fireman's work and thereby avoid the risk of a fine for permitting the chimney to emit smoke as dense as No. 2 or 3.

A limited number of these charts have been printed on heavy cardboard and will be sent to subscribers of *Power* who so request.

Such a chart permits the engineer to make a study of how firing conditions influence the emission of smoke. At one plant, an observer with the chart and a stop watch was stationed at a distance from the plant to note the exact time of any change in smoke density. A second observer within the boiler room noted the time and the character of all changes in the firing conditions. Comparison of the two reports revealed that firing was too heavy and infrequent.

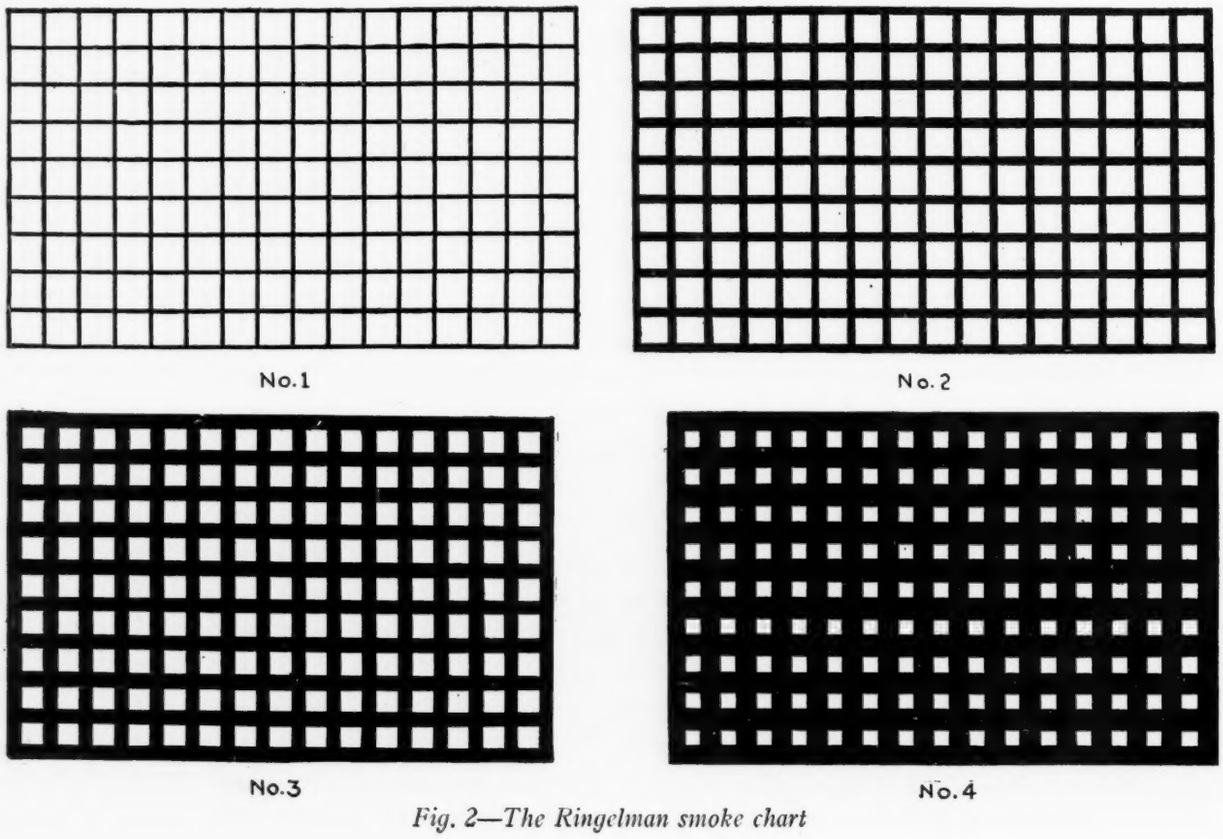


Fig. 2—The Ringelman smoke chart

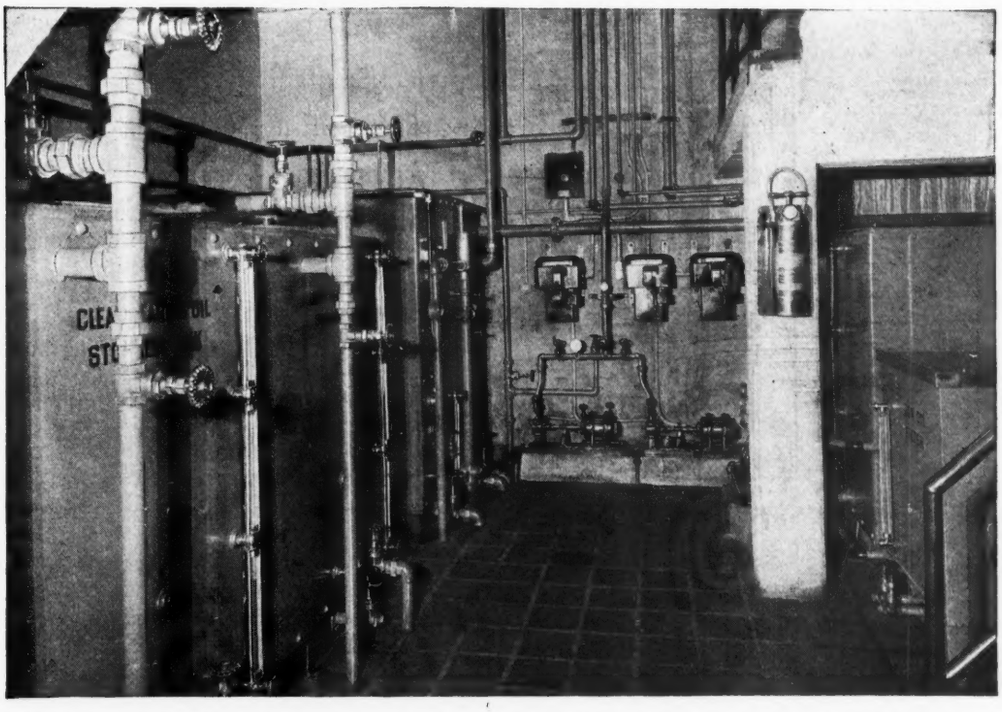


Fig. 1—General view of oil room, showing station bearing oil tanks and filter at left, bearing oil pumps in background and governor oil storage, filter and pump at right

Station "Trickle" System

Eliminates Periodical Changing of Oil in Bearings

By E. C. Bacot
Assistant Hydraulic Engineer,
Byllesby Engineering & Management Corporation

IN THE recently completed Ohio Falls hydro development of the Louisville Gas & Electric Company the methods of handling bearing and governor oil are of interest, as they differ in certain respects from the usual. The standard unit system for bearing lubrication with individual oil pump and filter for each unit is supplemented by a continuous station supply equipped with a large filter and storage tanks, so that, while the supply of bearing oil in a unit is being circulated constantly through its individual filter, the supply is being renewed continuously from the station "trickle," or bypass system.

The overflow from each unit is passed to the station filter and returned to the gravity feed tank or temporarily to storage. Individual governor-oil tanks also are supplied from a station system provided with filter pump and storage, with special facilities for receiving new oil and for replacing used oil with the new or filtered supply.

Thus all oil in the station is handled through piping arranged for gravity feed and return. Clean oil under pressure is available at all times at any piece of apparatus in the plant requiring it. Such a system makes it possible to drain the oil from any bearing reservoir or governor tank and replace it with clean oil in minimum time merely by the manipulation of two valves, as each point where oil is received is permanently connected to the oiling system.

As will be recalled from the description of the plant appearing in Feb. 7 issue, this development contains eight vertical units, each consisting of a 12,500-kva., or 10,000-kw., generator, driven by a 13,500-hp. propeller-type turbine. The main power house structure is 507 ft. long and 46 ft. wide, the entrance doorway being at the end of the building and opening upon an entrance platform or gallery at elevation 452, which is 16 ft. above the generator floor. The governor sump, or relief, tanks are along a longitudinal corridor extending the full length of the power house at elevation 408, each tank being set in a pocket in the concrete foundation alongside the passageway and immediately below its corresponding governor unit.

The oil room, containing the station oil-storage tanks, filters and pumps, is at the entrance end of the building,

In an eight-unit hydro-electric plant, station trickle system supplementing individual unit oiling systems maintains constant circulation of cool oil at all times, facilitates transfer of oil from bearing reservoirs on governor tanks and reduces labor and waste in the handling of the oil.

below the entrance platform, at elevation 400, the lowest floor in the building. Separate clean and dirty oil-storage tanks, as well as separate piping systems are provided for the bearing and governor oil, as different grades of oil are required for the two classes of service.

Both governor and bearing oils are emptied from cars at the entrance of the building, into a special floor strainer set flush with the floor of the main entrance platform at elevation 452. Details of this strainer are shown in Fig. 4. Attention is called to the annular groove to catch dirt or floor drip, a source of trouble in most installations of this kind.

From the strainer, the oil runs by gravity through a 2-in. pipe line to either a 1,500-gal. clean governor-oil tank, located directly below on the floor at elevation 436, or to the clean-oil compartment of a 2,000-gal. bearing-oil tank located vertically below in the oil room. The same 2-in. pipe line from the strainer to either tank is used for either oil, as it is vertical and drains completely after use.

From the bottom of the clean governor-oil tank a 2-in. pressure line drops vertically 23 ft. and runs horizontally along the side wall of the corridor for approximately 500 ft. to each of the eight governor tanks, the tops of which are at elevation 414, giving an average pressure head of 26 ft. Individual governor-oil tanks are drained through a 3-in. gate valve in the discharge connection to a 3-in. drain header, of seamless drawn steel tubing hung on suspension hangers, in the pipe trench in the floor of the corridor at elevation 408. This pipe has a slope of about 18 in. in its length of 400 ft. and empties into a 1,500-gal. dirty-oil tank on the floor of the oil room. Here one end of a ¾-in. twin-tandem, 240-gal. per hour, motor-driven pumping unit transfers the oil from the dirty-oil tank to a filter, while the other end elevates the oil from the filter to the clean-oil tank above, from which it is fed by gravity to the unit governor tanks, thus completing the cycle.

Oil for bearing lubrication is circulated continuously at the rate of approximately eight gallons per minute, or one gallon per minute per unit, through the entire system of bearings, piping and filter by ½-in. motor-driven positive-displacement rotary pumps installed in duplicate. Incoming oil, as previously stated, is dumped

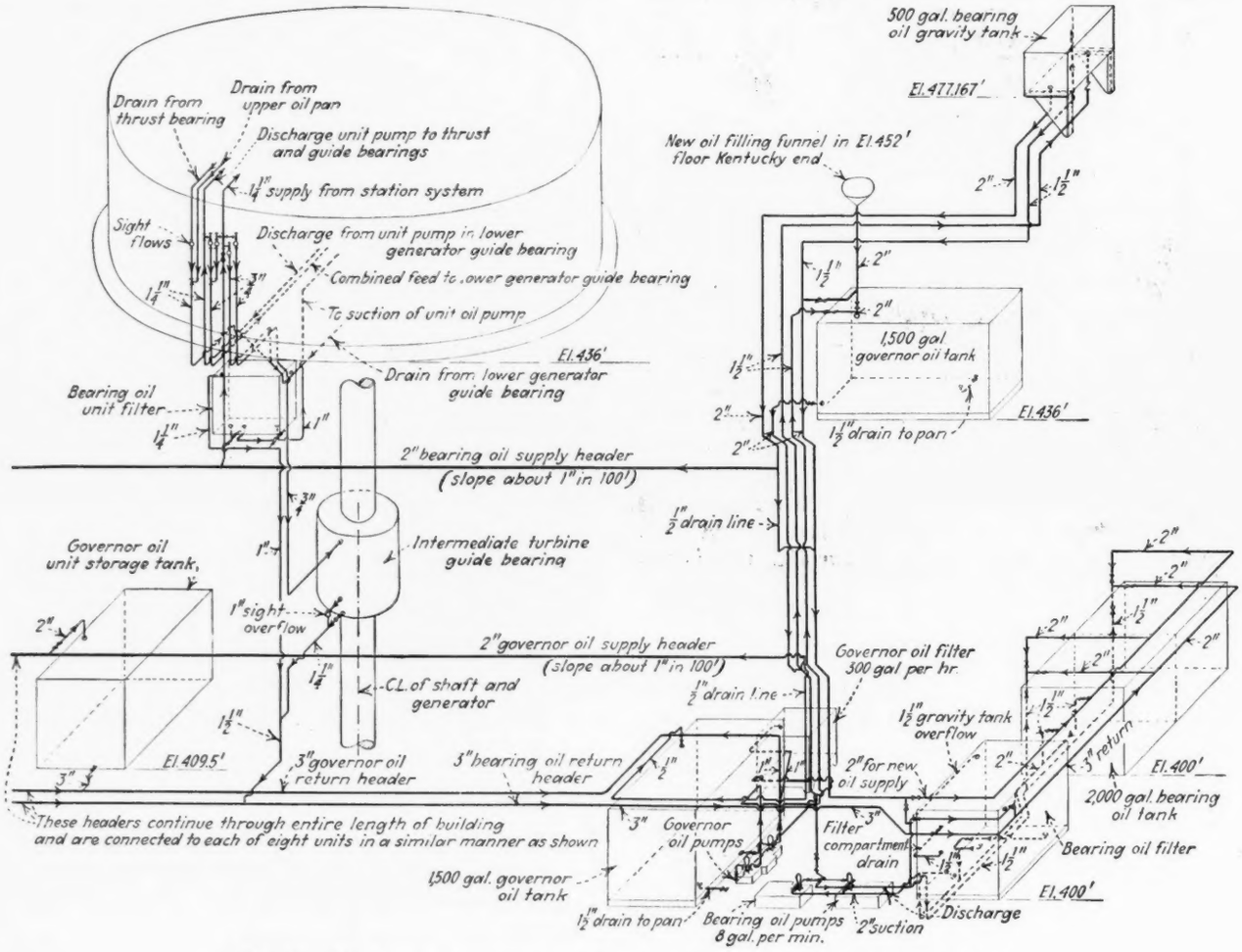

500 gal. bearing oil gravity tank
El. 477.167'
New oil filling funnel in El. 452' floor Kentucky end
Drain from thrust bearing
Drain from upper oil pan
Discharge unit pump to thrust and guide bearings
1¼" supply from station system
Sight flows
Discharge from unit pump in lower generator guide bearing
Combined feed to lower generator guide bearing
To suction of unit oil pump
El. 436'
Drain from lower generator guide bearing
Bearing oil unit filter
1,500 gal governor oil tank
El. 436'
1½" drain to pan
2" bearing oil supply header (slope about 1" in 100')
½" drain line
Governor oil unit storage tank
Intermediate turbine guide bearing
1" sight overflow
2" governor oil supply header (slope about 1" in 100')
Governor oil filter 300 gal per hr.
CL of shaft and generator
½" drain line
1½" gravity tank overflow
El. 409.5'
3" governor oil return header
3" bearing oil return header
2" for new oil supply
3" return
El. 400'
2,000 gal. bearing oil tank
These headers continue through entire length of building and are connected to each of eight units in a similar manner as shown
3" Governor oil pumps
Filter compartment drain
Bearing oil filter
1,500 gal. governor oil tank
El. 400'
1½" drain to pan
Bearing oil pumps 8 gal. per min.
2" suction
Discharge

Fig. 2—Diagram of governor and bearing oil systems for eight-unit plant

from the car through the floor strainer to either the clean or dirty end of the two-compartment, 2,000-gal. tank in the oil room. From this tank it is elevated by either rotary pump to a 300-gal. pressure tank attached to the face of the generator room wall above the main entrance at elevation 477, being first passed through the station filter if desired. To insure that this gravity tank shall remain full, the oil is supplied to it at a rate of approximately one gallon per minute in excess of the combined maximum possible discharges through the oil feeds to all units. All overflow passes back through an overflow pipe to the pump intake in the oilroom.

Clean oil from this gravity pressure tank flows through a 2-in. pressure header attached to the ceiling below the generator-room floor at elevation 436, from which it passes up through the floor to the sight feeds attached to the side of the generator frame, as shown in Fig. 3 on this page. The standard arrangement of generator-shaft driven unit pump provided with a small unit filter has been retained, so that in case of any interruption in the station "trickle" supply, the units may continue to operate in the usual way. These small filters also obviate the possibility of any pipe scale or burrs that may be picked up in the pipe runs reaching the bearings.

Duplicate sight feeds are provided for each generator bearing, one being supplied from the unit pump and the

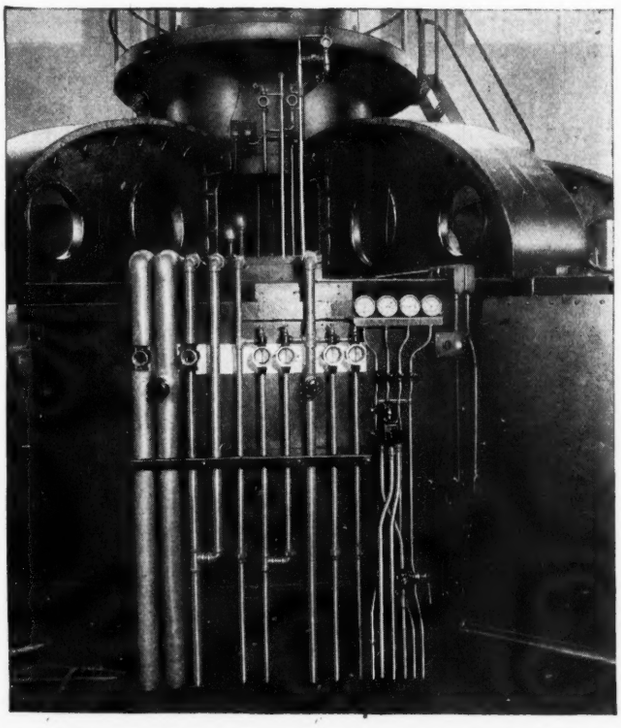


Fig. 3—Unit bearing oil sight feeds on side of generator frame

Cooling-water piping for thrust bearing shown at the left. Air and water gages for brakes and unit air cooler at the right, also motorman's air valve for emergency hand control of generator brakes.

other from the station "trickle" system. In addition, a line with sight feed is provided for the main-turbine shaft-alignment bearing and one for the dirty side of the generator's small unit filter.

An amount of oil equal to the inflowing oil from the station "trickle" supply drains off through the overflow of the generator unit filter and, together with the drainage from the turbine shaft bearing, is piped to a 3-in. drain header. This header is located in the same floor trench that contains the governor-oil piping, and is carried back to either the filter or the oil-storage tank in the oilroom.

In the oilroom a flexible arrangement of piping is provided so that the oil can be transferred easily from the filter and tanks, from either compartment of the stor-

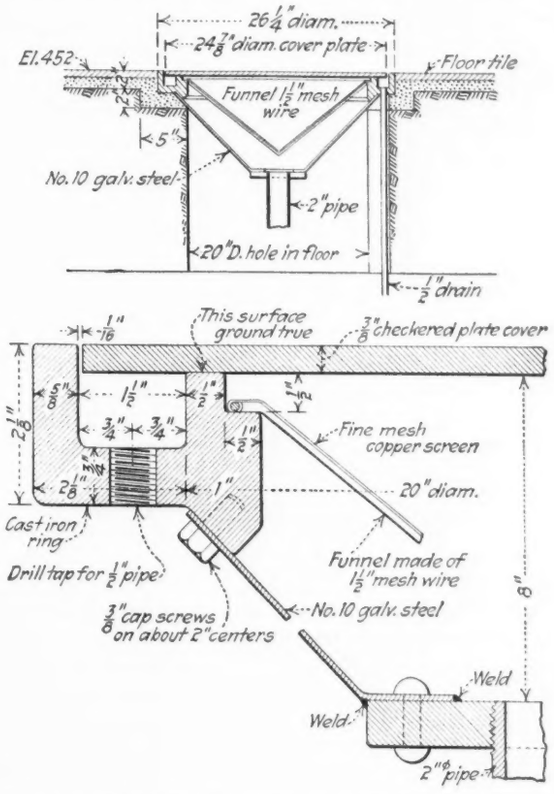


Fig. 4—Section of funnel in floor and detail of construction

age to the other, or be pumped from either tanks or filter to the overhead gravity tank. On the latter tank a float-actuated bell alarm is provided to give warning of a low oil level therein. The bearing-oil pump operates continuously. An automatic switch brings into operation the relay pump in case of failure of the pump.

All oil piping is of seamless drawn-steel tubing with thin walls and field-welded joints, so that all straight runs are continuous. At angles or branches flanged fittings are used with the pipe flanges rolled onto the pipe. No threaded fittings are used except in sizes below 2-in. These rolled flanged joints have proved very satisfactory, as practically none of the usual leakage troubles common to screwed joints in piping used for handling oil have been experienced.

In the smaller sizes screwed fittings were used, with iron-pipe-size drawn-steel tubing, owing to the difficulty of securing sufficient room for flanges in the space available. Great care was exercised in threading and assembling these joints and only a few slight leaks were encountered, which were later gone over.

All tubing was carefully cleaned prior to erection, the burrs were removed from the ends, the sections were blown out with compressed air and the interior cleaned by running a swab through the pipe. Finally, the interior of each section was inspected by means of a light. No evidence whatever of scale, burrs or foreign matter has developed since operation was started.

In addition to the oil pumps and filters all oil tanks were furnished by the S. F. Bowser Company. The governor-oil filter has a filtering capacity of 300 gal. per hour, while the bearing oil filter was provided with the large capacity of 1,200 gal. per hour to take care of filtering large quantities of oil in emergencies.

The cost of the entire system was comparatively small, and its use has resulted in reducing to a minimum loss of time and waste of oil with the attendant mess. Low oil in bearing reservoirs has been eliminated.

For example, the initial supply of 10,000 gal. of oil required for the entire station governor equipment was transferred from a tank car and distributed to the eight governor units in about four hours, with a waste of less than one gallon. A generator thrust bearing that would require four hours to fill from barrels, is emptied or filled in less than fifteen minutes and without wasting a drop of oil. Periodical changing of oil in bearings has been eliminated entirely, and the oil is at all times uniformly clean.

Operation of Waterwheels at Small Gate Openings

BY J. TALLA

OPERATORS of hydro-electric plants on irrigating systems, where power is merely a byproduct, have problems that do not arise on systems where power is the main product. On irrigating systems water orders are given twice each day, and the proper amount is let out from the storage dam through the turbines to supply the demand. The power plants below the storage dam are not allowed to cause any fluctuation in the flow of the water.

The governors are operated with load limits or stops on them to prevent them from opening the gates more than a predetermined amount, but are free to close the gates in case the speed of the waterwheel is too high. The power plants are also provided with automatic siphons or spillways to take care of the water if it is not possible to use it through the machines during line trouble, etc.

The turbines are operated whenever the water order is sufficient to make power and at other times as synchronous condensers.

During the winter the water orders are small and power may be supplied by steam plants and the hydro-electric units used as synchronous condensers when necessary.

The machines in the plants of the Salt River Valley Water Users' Association near Phœnix, Ariz., are started with water operating the turbines and are synchronized, after which the wicket gates are closed as tightly as possible. The turbine gates leak some and form a partial vacuum in the draft tube. This caused the atmospheric pressure to force the water so high in the draft tube as to cause the runners to be flooded. The water acted as a brake and increased the power required to operate the machines.

A 700-hp. turbine at 18-ft. head and a 1,400-hp. machine at 35-ft. head used about 250 kw. each to deliver nearly full load in leading kva. into the line when operating as synchronous condensers. We tried closing the main gates and letting air into the draft tube through the wicket gates in the open flume. The load then dropped to less than 50 kw. for each turbine to deliver full load in leading kva. into the line, a saving of 200 kw. A 2½-in. pipe was then installed in the top of the center bearing, which is in the draft tube. This pipe was extended above the water line in the wheelpit, and a valve was installed on it. When operating the turbine at just sufficient gate opening to float the generator on the line, a reduction of 75 kw. was made upon opening the air valve.

An 8,750-kva. generator driven by a 11,500-hp. turbine operating under a 110-ft. head, was not very efficient under light loads or when used as a synchronous condenser. As an experiment four holes were bored in the manhole door in the draft tube and tapped for 2½-in. pipe plugs. The machine was tested under various conditions with the results noted below:

Gate Opening	Vacuum, In., Hg.		Kw., Load
0.11	7¾	4 Plugs out and one-inch drain valve open.....	923
0.11	8¾	4 Plugs out and one-inch drain valve open.....	900
0.11	9¼	3 Plugs out and one-inch drain valve open.....	343
0.11	10	2 Plugs out and one-inch drain valve open.....	313
0.11	10	1 Plug out and one-inch drain valve open.....	293
0.11	10	Everything closed.....	286
0.09	6¾	4 Pipe plugs out and one-inch drain valve open...	735
0.075	6	4 Pipe plugs out and one-inch drain valve open...	554

Further tests were made, and we found no increase of efficiency by letting air into draft tube above 0.25 gate opening. Some of the late designs of turbines have provisions for letting air into the draft tube through the bypasses in the speed ring or in the wheel, to break up the eddies and increase the efficiency at light loads.

Mormon Flats dam and plant of the Salt River Valley Water Users' Association

We have come to the following conclusions from these tests:

1. The vacuum formed in the draft tube with small gate openings causes the water to rise so high as to act as a brake, as the wheel passages are not full of water flowing through it.

2. Letting air into the draft tube is beneficial to turbines that are operated at small gate openings or as synchronous condensers.

3. That the point of admission of air into the draft tube is not important, the main purpose being to reduce the vacuum in the draft tube in order to let the wheel run freely or let the water get away from the wheel. The ideal point would be immediately below the center of the wheel in a vertical machine.

4. The amount of air admitted will have to be decided by experiment.

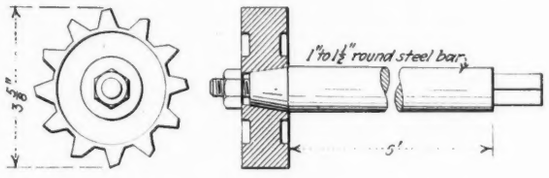
5. Pitting of the runner will be reduced.

Right Out of the Plant

BOILED-DOWN EXPERIENCE PASSED ALONG TO THOSE WHO MUST SAVE MONEY, IMPROVE THE PRODUCT AND KEEP THE PLANT RUNNING

Handy Boring Tool for Economizers

IN MANY power plants fitted with cast-iron economizers, trouble is experienced in keeping the pipes clean, particularly when hard water is used and no softening plant is installed. In these conditions it will be found on opening the economizer after, say, three months' running that scale has formed in the pipes to a



The cutter made from a gear wheel

thickness of one-fourth inch at the inlet end and gradually decreasing toward the outlet end. It will be found that this scale is heaviest in the first six rows of pipes and in the top half of the pipes.

It is a difficult job to remove this scale, but the following simple tool can be made by any handy man, and if used regularly it will be found to be quite effective.

Get a small toothed wheel, turn the teeth in a lathe to a diameter one-eighth inch less than the bore of the pipes and give the teeth a cutting edge and clearance. Now fasten this cutter head to a round or square steel bar about six feet long or longer if there is headroom over the economizer. With a wrench to turn the cutter you can begin operations; it requires no feeder as its own weight is sufficient. A guide piece of wood with a hole in the center will keep the boring bar central. With moderately hard scale six pipes can be easily cleaned in a working day, or more if the economizer is allowed to cool off for two or three days, which tends to soften the scale. With softer deposits of scale the job is speeded up by running a supply of water through the pipe being bored; where the deposits are very soft a hand scraper is better than the cutter.

A. WINDROSS.

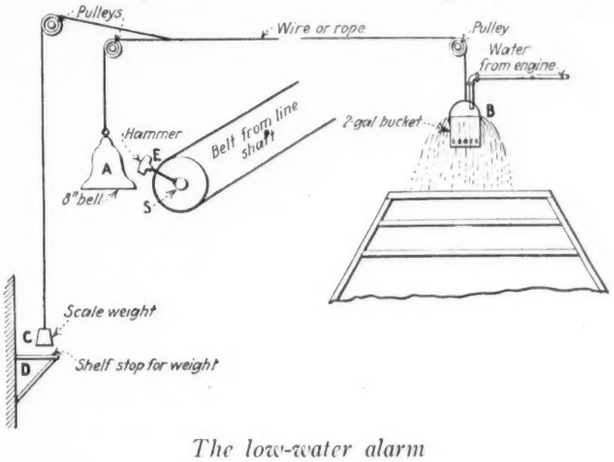
Stockport, England.

A Low-Water Alarm for Diesel Engines

THE necessity for protecting an oil engine against cooling-water failure is well known. Engines employing a belt-driven pump for circulating cooling water are at all times subject to the dangers of cooling-water failure due to a loose belt, or the belt coming off, the pipes becoming clogged with trash, and accumulations within the discharge passages and the engine jackets that will prevent proper and adequate flow of water. There are thousands of installations in service without any kind of protection whatever, and the owners are slow to adopt many kinds of low-water alarms offered them because of the apparent complication and cost of many such devices. In the work of installing oil engines I have helped the owners work out a number of devices for this purpose. Often it is necessary to make use of such material and equipment as may be at hand or obtainable locally. The design shown in the illustration is both simple and practical and was made from materials found around a flour mill where a 60-hp. engine was being installed. The belt-driven centrifugal pump for water circulation is driven from a pulley on the engine shaft and discharges through the engine jackets to the cooling tower. If the pump fails, water will be retained in the engine jackets but will not circulate.

A bucket with several holes punched in it was suspended above the cooling tower and received the hot water from the engine. From the bucket a small rope was run over pulleys to connect with weights and a bell in the mill. The weights were slightly lighter than the water in the bucket. When the water stops flowing, the bucket is drained in about ten seconds. The bucket then rises and, consequently, lowers the bell and the weights. The weight *C* comes to rest upon shelf *D* a few inches below its regular position. The bell *A* drops down and contact with hammer *E* fastened to shaft *S* is made. The shaft is a part of the mill machinery and revolves whenever the engine is in operation. The slowly revolving shaft causes the bell to ring constantly until water is again in the bucket and the weight raised.

When the fuel oil fails or the engine begins to slow down for any other cause, the bells rings, for a slight



The low-water alarm

decrease in the flow of water allows more to leak from the bucket than runs into it, thus lowering the weight.

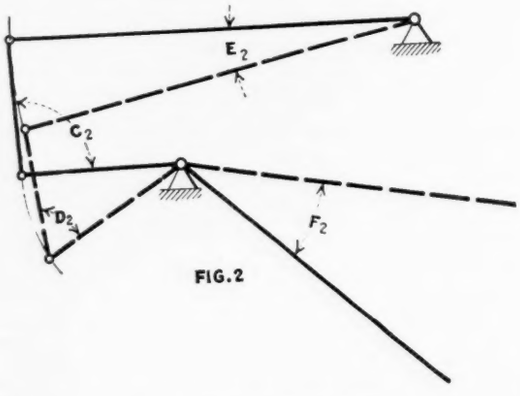
The first occasion to note the working of the alarm was when the engine began to slow down, owing to lack of fuel in the tank. At another time trash clogged up the water discharge pipe near the entrance to the cylinder. Each time the bell gave proper alarm. Another practical point is that the bell rings each time the engine is started and stopped. Unlike devices that ring only in trouble, this alarm working daily gives the owner evidence that it is in working order at all times.

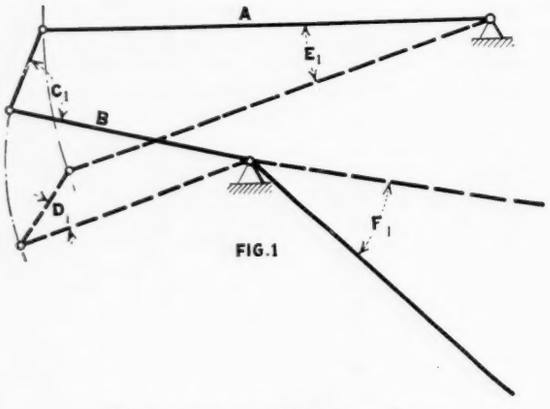
Memphis, Tenn. ORVILLE ADAMS.

Correction of the Steam-Flow Meter for Change in Size of Orifice

THE steam-flow meter is one of the most important instruments in a power plant. It is therefore necessary to keep it in good condition. Let us assume that the meter is tested in connection with the right orifice by the manufacturer for given conditions as to steam pressure and temperature.

But when the meter is installed, it frequently happens that it is not used with the proper orifice, which would produce the necessary pressure drop to show the correct steam flow. Frequently also, the superheat or the steam temperature is higher or lower than the meter is designed for, but these points are of minor importance. The fact is that for a given type of meter the exact pressure





Figs. 1 and 2—Diagram of levers and points of suspension

drop is not produced by the orifice to show the right flow of steam. In one case a check with the venturi meter in the feed-water line showed as much as 25 per cent lower reading on the steam-flow meter, even when the latter instrument had been cleaned and filled to the right level with mercury. The following shows how the meter can easily be corrected.

After having the meter cleaned and checked with a water head on the high-pressure pipe, also checked with the data given by the manufacturer and by the average rating, check the flow through the meter with a venturi meter in the feed-water line by taking into account the steam pressure, steam temperature and water temperature. The meters show, say, 25 per cent less steam than water. In other words, the low meter must be set 33.4 per cent higher. The manufacturer gives pressure drop data as shown in curve 1, Fig. 3. A new curve, 2, should be designed which gives for a certain pressure drop a higher reading of the amount that the meter must be set higher, in our case 33.4 per cent. Now the relation between the levers A and B (Figs. 1 and 2) must be changed in the same ratio.

It is to be observed that the angles are the same as far

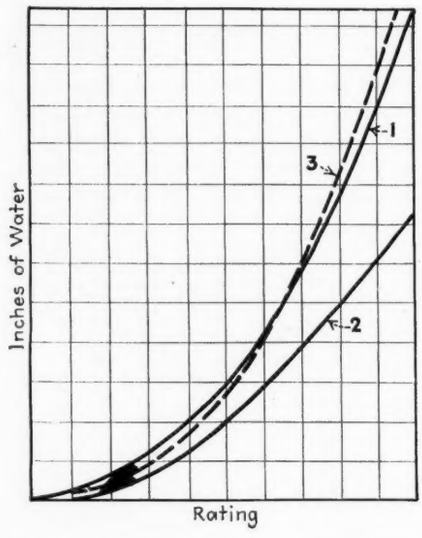


Fig. 3—Correction curve for reduced pressure drop

as possible by the lowest and highest reading. Therefore the length of both levers A and B must be shortened. In case the meter shows a higher reading, the levers must be lengthened. How this can be done in a simple manner is shown in Fig. 4. In a slot is the slide *a*, the position of which can be changed by opening the screw *b*. When the screw is fixed, the swing *d* can move freely as the screw presses the washer *c* and the slide against

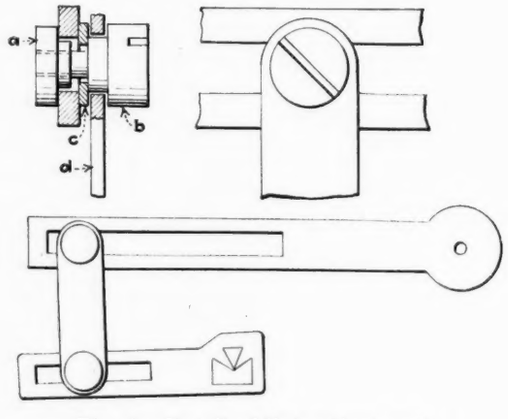


Fig. 4—Detail of link adjustment

the lever. Also, the length of the swing must be changed. This being done, again put the water head on and move the pen from 0 to 100 per cent rating.

It is important that the angles C_1 and D_1 and angles C_2 and D_2 respectively (Figs. 1 and 2) shall be about the same, as a change of these angles shortens the actual length of the swing and causes the meter to read too high in the lower ranges and too low in the higher ranges.

New York City. H. WEBER.

As the Other Fellow Sees It

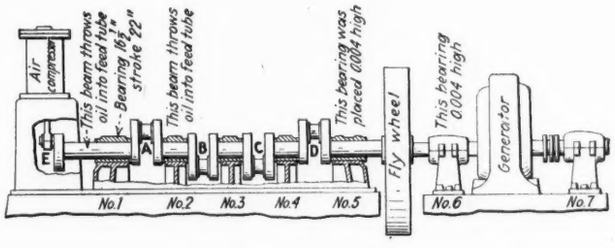
WHERE THE MAN WHO AGREES OR DISAGREES WITH AUTHORS OR EDITORS HAS A CHANCE TO SPEAK UP

Aligning a Diesel Crankshaft

READING the article by J. H. Bender, of Duncan, Okla., on crankshaft alignment in the July 17 issue, reminds me of experiences with a four-cylinder vertical Diesel rated at 460 hp. at 180 r.p.m.

The engine had experienced a broken frame before I came into charge of it. It made a very good record for both economical operation and reliability, but there seemed to be considerable trouble with bearings.

Later on, after being in use a few years, it suffered a broken crankshaft. After installing a new shaft and making other necessary repairs, the engine was used only



Layout of the bearings

intermittently or when needed during heavy load periods. Finally, it was taken down and moved to another town. Bearings were rebabbitted, new cylinder liners, new pistons and rings, needle valves and new exhaust valves were installed.

This work was all supervised by a factory engineer, who directed all work. When taking the engine down, we found the bearing between the flywheel and the generator had been hot at some time and had been so low that the generator rotor had been dragging.

The caps on the bearings Nos. 1 and 2 were loose. It had been noticed that oil was thrown up into the oil sight feeds on these two bearings, due to a whip of the crankshaft. There had been also a heavy thump at every revolution of the shaft.

When the shaft was removed, one side of bearing No. 2 showed wear, but the opposite side showed none at all. This seemed due to a sprung shaft.

When the erecting man leveled the frame with an engineer's level and put all the bearings in their places, he set No. 6 bearing, between the flywheel and the generator, 0.004 in. high, also bearing No. 5, between frame No. 4 and the flywheel, was set 0.004 in. high, and the others all were set in line. But when we placed the crankshaft in the bearing, No. 1 bearing showed the shaft sprung between 0.001 and 0.002 in. The erecter scraped No. 1 bearing down, to split the difference between No. 1 and No. 2.

I questioned the desirability of this, but he said it would work. After the engine had been in operation for two months, the oil began to be thrown up into the oil-feed tubes and sight feeds, showing that the shaft was whipping. There is a heavy slapping thump now at the end of the shaft to which the air compressor piston is connected.

The questions are: Is this a safe condition in which to operate this engine? Could this shaft have been straightened by peening the crank throw for No. 1 cylinder? Is there danger in taking out the bearing-cap shims and pulling the caps down on No. 1 and No. 2 bearings?

There has not been a worn bearing on this engine even though it has been run only three months, twelve hours a day, since having been erected here. I am not criticizing the erecting engineer for his work, but I would like to know if there is any danger of the shaft's breaking when running this way.

I would appreciate a few words from any reader who is better posted on Diesel engines. E. B. PRINE.

Dallas, Tex.

* * * *

Imagine the Savings

I have read the many editorials in *Power* on the subject of "Imagine the Savings" and have expected to see discussions by engineers on the various suggested savings.

Tremendous savings have been realized in the generation of power in central stations and industrial power plants during the last ten years through changes in the design of equipment and plant personnel.

The recent developments in high pressure, high superheat, boiler ratings of 400 per cent and stock temperatures of 300 deg. and less, have required the expenditure of a tremendous amount of money, all for the purpose of saving dollars in the long run.

The modern power engineer is, however, astounded when he observes the waste in manufacturing processes and the determination on the part of many plant executives to cling to the old methods and actually to fight to the last ditch any changes, even though the changes would save power, labor and time.

The management is often opposed to any changes that would presumably save money, because it fears the changes may lower the quality of the product and thereby result in the loss of business.

Human nature is a difficult thing to deal with when one is attempting to reduce production costs, and after a great many experiences I wonder if it is not best in the long run to change the design deliberately or change the whole process if need be.

Great savings are possible in the heating of buildings. Steam heat and ventilation are terribly abused. The use of thermostatic control, high vacuum on the system in mild weather and cutting off the heat altogether before starting to open windows will save an average of 30 per cent of the coal bills if we can get the chief executives interested first and then carefully and gradually introduce the changes.

Paper mills could save a lot of steam by beating the stock properly before letting it down into the stock chests. If the stock is short, the machine tender will open wide a 1½-in. steam pipe into the "save all."

The preparation of the stock also greatly affects the drying and the removal of water at the suction boxes or rolls. Much of this results from squeezing down the power consumption too closely.

Rubber mills, textile plants and laundries would increase their output and reduce losses due to waste steam into sewers, if more dependable systems were utilized to trap out the condensation in vulcanizers, hot rooms, kettles, coils, mangles and driers.

Steel plants and glass plants often save much money through the purchase of trade-marked coal having a high volatile, and a low sulphur content and a high fusing ash, which are the desirable characteristics of coal for raw-hot-gas producers.

Thousands of small and medium-sized power plants have been closed down because of a wave of popularity among executives for the use of purchased power and their desire to be relieved of the responsibility of their own plant. Many of these executives have already found that they have not been relieved of the major portion of the old troubles and anxiety for continuous operation. They have in most plants only shut their engines down and contracted to pay for a service over which they have no control. The service is deplorable in many localities or sections of the country, making it necessary to change the production schedules, and to lay off good workmen when their services are really needed.

Franklin, Ohio. WALDO WEAVER.

* * * *

The Vulnerable Spots

I FULLY agree with the contention in the editorial entitled, "The Vulnerable Spots," in the Aug. 14 issue, that reliability is a prime requisite of any piece of equipment.

Even though equipment cannot be entirely reliable, a study of the causes of failures in machinery and equipment will do much to increase their reliability. The engineer should search out the causes of machine troubles, with the view of incorporating features in new designs to prevent breakdowns.

This engineering service for the user of the equipment can be made a source of ideas for the equipment builder and can be used as a means of gaining contact with the responsible heads of the purchasing company.

The cost of the engineering services may be high, but the builder of the equipment is amply repaid.

Merchantville, N. J. JOSEPH VIGGIANO.

I BELIEVE the editorial on the reliability of hydroelectric units in the Aug. 14 issue points the way to closer co-operation between operation, maintenance and design engineering. One of the great difficulties in improving the vulnerable spots in any product is the lack of just such information for the engineer's guidance.

I believe the time is ripe for closer intelligent cooperation between user and manufacturer, particularly in the case of large, expensive items of power-plant equipment where all the real difficulty may be concentrated in a few small units or parts, generally unknown or known only in a minor degree to the designer. To remedy this condition, it is up to the manufacturer to provide an easy means of making such a report as a matter of routine. To provide comparable data, it should all be submitted in approximately the same way on a regular form.

In sending out new power equipment, why would it not be logical for the manufacturer to provide a small protected pocket on the machine, which could be filled with form cards suitable for such reports? Columns for date, unit or part, time out, and repair required would give all the essential data. A formal request posted over this pocket or accompanying other instruction for the use of the equipment, would tell of the advantages of recording these data to both user and manufacturer. A formal letter inviting transmittal of filled-in cards every six months or year, would not only obtain such cards and show the manufacturer's interest, but would also serve as a follow up on those who have overlooked the filling out of these cards. This would not only obtain the data in usable form, but it would eliminate all tendencies to send out those annoying meaningless letters beginning, "You now have our equipment installed six months, and we trust you have found it satisfactory in every particular, etc.—," which after all accomplish nothing tangible.

The data so received, properly classified and analyed would point the way clearly and definitely to the units on which attention should be centered when improvement design is contemplated. Weak points can even be redesigned with the thought of providing replacement units if the situation appears to warrant it, for good will is a mighty big asset. J. W. CAMPELL.

Conshohocken, Pa.

* * * *

Weighing Ashes

F M. AHER'S contribution in the Aug. 7 issue outlining various means for checking the weight of coal or ashes handled by skip hoists and cranes recalls an ingenious device applied by an engineer for the International Harvester Company to an ash skip hoist at its Chicago plant.

This device consisted of a mechanical counter, which was actuated by a lever terminating in a roller having contact with the hoist rope as it left the drum. Its operation was based on the amount of rope travel across the face of the grooved drum which took place during a single complete hoist cycle of the skip bucket. The roller touched the hoist cable only at one end of this travel; consequently, it was actuated only once for each load of ashes handled by the skip bucket. The counter, being in effect an adding machine, recorded the total number of bucket loads that were handled, no summation being necessary.

This device was applied primarily to permit ash-handling labor to be paid by piecework. Incidental advantages have been gained in giving accurate information as to the cost per ton of ash handled, the life of hoisting cable and other similar records.

Various modifications of this same idea have been applied successfully to both full-automatic and semi-automatic skip hoists handling coal, coke, ashes and other bulk materials.

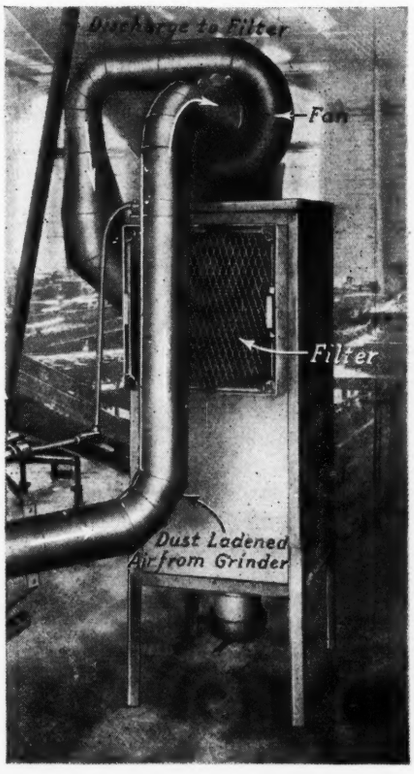
Strictly speaking, they provide only a volume measurement of material and not an actual weight. However, slight variations in the weight contained in a skip bucket from one cycle to the next constitute compensating errors, so that the total weight is usually very close to the actual tonnage handled. Ordinarily, of course, this accuracy is quite sufficient, as only a check on the total tonnage is desired, since a weight larry is usually employed to provide accurate individual weights of coal delivered to each boiler. C. C. PLUMMER.

Chicago, Ill.

Air Filter Adapted for Use in Grinding Operations

THE illustration shows an adaptation of the type U-2 filter manufactured by the Midwest Air Filter Company, Bradford, Pa., for cleaning the air discharged from all kinds of metal grinding, buffing and polishing machines.

As will be seen from the illustration, the filter section is incorporated in an airtight housing built of structural steel and sheet iron. The



Use of filter permits recirculation of carrier air

dust-laden air from the machine is drawn by a fan and discharged to the filter chamber, from which it passes into the room again through the filter. The housing is sufficiently large to cause a slowing down or expansion of the air upon reaching the chamber, and this change causes the heavy particles to fall to the bottom, the finer particles being caught in the filter.

Some of the advantages claimed for the arrangement shown are that it can be installed inside the building, close to the machine or group of machines, and thus shorten the exhaust piping required; the air is recirculated, which gives a considerable saving in heat, especially in the winter time; it requires less space than the usual centrifugal type of separator, and has a large dirt-holding capacity. The dirt is removed at intervals through an opening in the bottom of the housing.

Device to Protect Ends of Screwed Pipe

A SIMPLE device designed to protect the ends of screwed pipe from erosive or corrosive action due to acids or entrained and dissolved

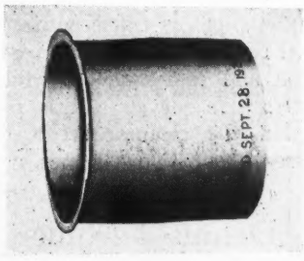


Fig. 1—Pipe saver of corrosive-resistant alloy

air or other impurities in water has been brought out by the Pipe-Saver Corporation, Carthage, N. Y.

The device is a piece of tubular metal as shown in Fig. 1 made of an alloy that is practically impervious to the action of most fluids and made to fit snugly inside the ends of pipe of any standard size.

The open end thimbles or "pipe savers," as they are known to the trade, are readily installed in the

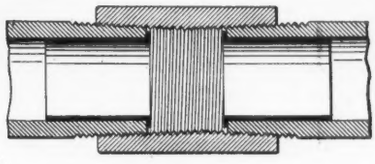


Fig. 2— Pipe savers inserted in pipe

pipe ends. After the pipe is threaded and reamed, the thimble is dipped in oil and then inserted in the pipe and seated by placing a block of wood against the flange and striking it with a hammer. The thimble is tapered slightly from the center to the ends in order to insure a permanent seating with varying pipe diameters.

In addition to protecting the ends of the pipe from wear and corrosion, the thimbles reinforce the pipe at the weakest point, the threaded section. Fig. 2 shows the pipe savers in place in two sections of pipe joined by a screwed coupling. These savers are intended for installations of new pipe and for use when replacing old pipe.

Commutator-Mica Undercutter

A NEW motor-driven commutator-mica undercutter has recently been placed on the market by the Ideal Commutator Dresser Company, Sycamore, Ill. The cutter in this tool is driven by a worm and gear connected to the motor through a long flexible shaft. The tool is so constructed that it is not necessary to remove any of the brushes when undercutting the commutator, as shown in the figure. The undercutting tool can be efficiently operated in a space three inches wide.

The slotter can be used on large or

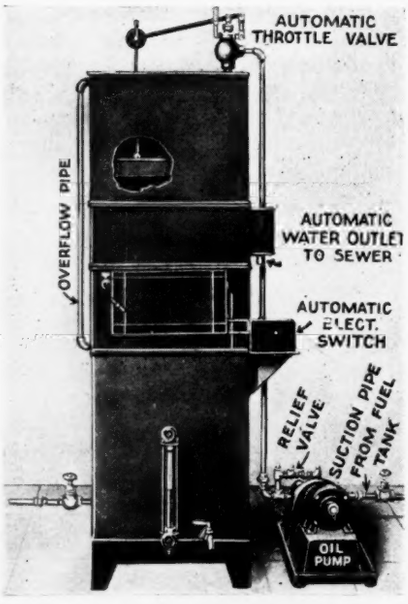
Commutator slotter can be used in small space

small commutators and will slot to within about $\frac{1}{4}$ in. of the risers. Worm gearing drive and small-diameter saws render the saw speed comparatively slow, thereby eliminating the tendency to jump out of the slot and gouge the copper.

There is a depth gage on the tool next to the cutter, so that the depth of the slot can be easily adjusted. A micrometer adjustable guide is provided, which is so constructed that it is only necessary to cut one slot by hand as the guide runs in the slot adjacent to the one being cut. A $\frac{1}{4}$-hp. alternating-current or a direct-current motor is supplied with the tool to do the driving. For alternating current the motors may be had for 110 or 220 volts 60 cycles, and on direct-current for 115 or 230 volts.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES



Fuel-oil filter with supply pump

Continuous and Automatic Fuel-Oil Filter

A TYPE of continuous and automatic fuel-oil filter, designed especially for cleaning oil for Diesel engines and oil burners, has been added to the line of oil-filtering equipment manufactured by Wm. W. Nugent & Co., Inc., 410-412 N. Hermitage Ave., Chicago, Ill.

The filter is divided into three compartments, a heating chamber, a water separating chamber and a filtering and clean-oil storage chamber. The heating chamber is normally fitted with either a steam, a hot-water or an electric coil and has a screen that removes the larger particles. From this chamber the oil flows to the one directly below, where it separates from the water, and the water is automatically discharged to the sewer. From the normal oil level in this chamber pipes are carried down to two or more filtering baskets composed of wire cloth of 100- to 250-mesh. From these baskets the oil passes directly to the clean-oil storage chamber.

Should the filtering baskets become clogged, owing to inattention on the part of the operator, the oil will overflow from the baskets into a bag overflow trough and cause an alarm to sound, notifying the attendants that the baskets need cleaning.

The filtering baskets can be readily removed through a door on the top of the compartment, and as each of the inlet pipes is fitted with a cock, the oil can be shut off one basket at a time and that cleaned, while the others are in service. It is pointed out that the cleaning of a basket requires about two minutes.

Dennis Turbine-Condenser Expansion Joint

A NEW departure in the line of turbine - condenser expansion joints is shown in the accompanying illustration. The joint is the latest development of the Dennis Engineering Company, Columbus, Ohio, and is designed to give maximum flexibility between the turbine and condenser, and is intended particularly for the larger installations.

As shown in the illustrations, a copper shield is expanded into place by inserting the split steel rings upon which the flat steel springs exert sufficient pressure to seal the joint properly with the flanged surfaces of turbine and condenser. In placing the joint, the steel rings are clamped together with the outside clamping bolts, and when these bolts are released the spring pressure is brought to bear on the rings, thus allowing perfect sealing of the joint without the use of flange bolts.

The joints may be installed in any position, horizontal or vertical, and will permit proper expansion in any direction without strain in the expansion joint. It is adjustable to a pipe section of any shape—circular, rectangular or irregular. Gaskets of either asbestos or rubber are furnished with the joint and are firmly attached to the copper shield.

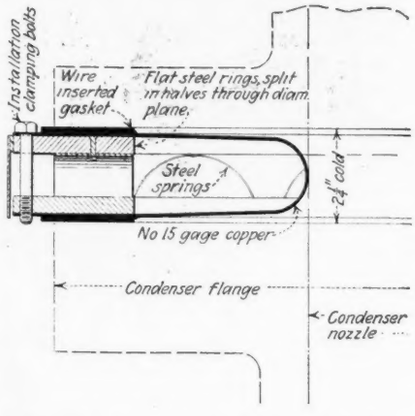


Fig. 2—Cross-section of expansion joint

Some of the advantages claimed for this joint by the manufacturer are simple installation, short face-to-face requirements of parts connected, no transmission of strains or vibrations between the turbine and condenser and entirely independent support of turbine and condenser.

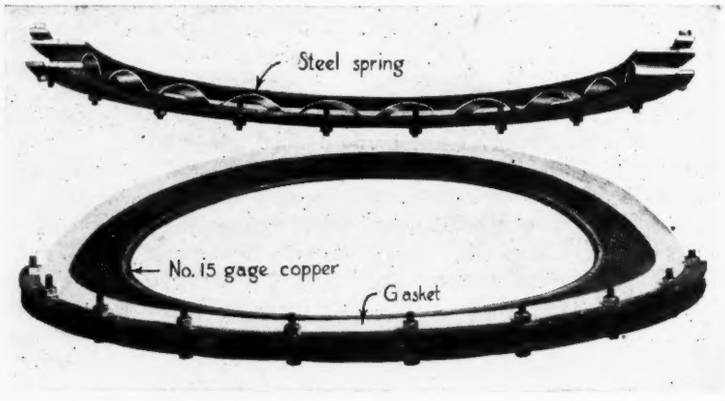
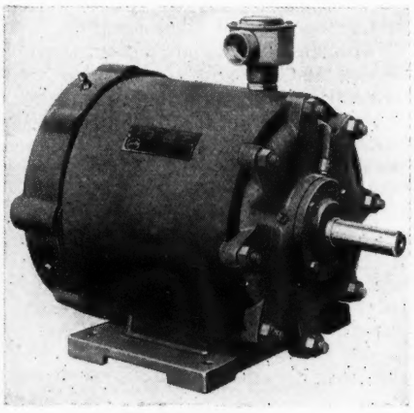


Fig. 1—Steel springs hold the joint tight in place of regular flange bolts

Allis Type EX Explosive Proof Self-Ventilated Motor

AN EXPLOSIVE-PROOF self-ventilated motor designed for use where explosive mixtures or fumes of gasoline, naphtha, acetone and alcohol are present, is a recent development of the Louis Allis Company, Milwaukee, Wis.



Type EX explosive-proof motor

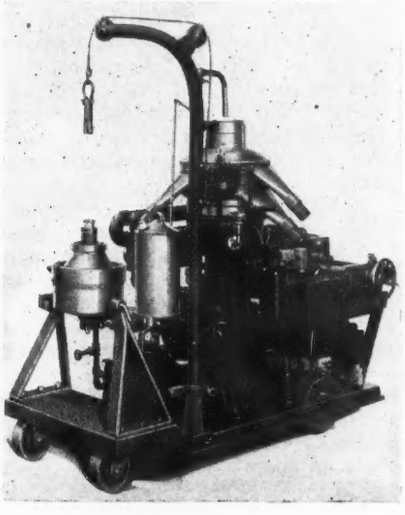
The motors are only slightly larger than the standard units of the same horsepower and are of comparatively light weight. For example, a 5-hp. 1750-r.m.p. motor weighs but 33 lb. more than an open-type motor of the same rating. No special mounting provisions are required. This type of motor is available in sizes up to 5 horsepower.

De Laval Portable Oil Purifier No. 700

A NUMBER of important advantages, including an increase in capacity of approximately one-third, are claimed by the De Laval Separator Company, 165 Broadway, New York, for its No. 700 portable insulating oil purifier. The outfit consists essentially of an all-steel truck, on which are mounted the following units: The oil purifier unit, having a maximum capacity of 800 gal. per hour; the 12-in. blotter press; three 6-kw. immersion electric heaters; two rotary pumps with motor; thermostatic heating cutout; bowl-cleaning vise and hoist; thermometer and clean-oil collecting tank with a float valve to regulate the flow of oil through the machine. The complete outfit is so piped as to give four combinations of operation: (1) Oil purifier, heater and pumps; (2) oil purifier with heaters, pumps and blotter press; (3) blotter press, heater and pumps; (4) pumps with or without heaters.

The construction and operation of the oil purifier are essentially the same as found in other De Laval machines. The purifier is equipped with a friction clutch pulley, which enables the bowl or rotating member to be automatically brought up to speed without overloading. The purifier also can be furnished as a non-aërating conservator type unit for use in connection with conservator transformers or as a stationary unit.

A thermostatic cutout in the oil line automatically trips the master magnetic switch in the heater circuit if the oil reaches a temperature of 150 deg. F., thus insuring protection to the heater. Heat is turned on again after the heater adjustment has been corrected, by operating the reset push button mounted on the magnetic switch. This switch is also connected into the pump motor circuit, so that the heaters cannot be energized unless the pumps are operating. The 12-in. blotter press is provided for use in series with the purifier, for treating badly carbonized oil, but for all other services it can be readily cut out of the line. The press takes its supply of oil from the purifier, so that only dry and practically dirt-free oil is passed through it. For services in which the removal of colloidal carbon from circuit breaker oil is not a problem, the blotter press may be bypassed or omitted from the equipment.



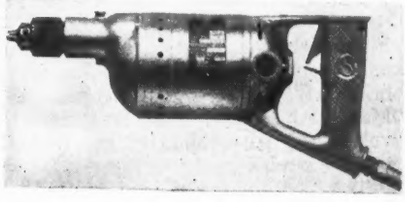
Portable insulating oil purifier with push-button control and bowl hoist

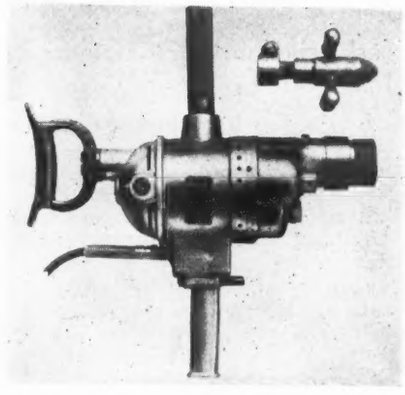
The pump equipment consists of two rotary pumps mounted on a single shaft and driven by a single motor through a sprocket and chain. One pump delivers oil to the purifier, while the other takes its supply of oil from the collecting tank, into which the purifier discharges, forcing it through the blotter press and thence back to the oil-holding tank, or directly from the collecting tank to the unit, depending upon whether or not the press is in service. The pump is capable of operating against a pressure of 100 pounds.

The swinging hoist, which is mounted on one corner of the truck, materially lessens the manual labor in handling the outfit and saves time in cleaning the bowl. The hoist is self-contained and may be slipped out of the socket which holds it, in order to clear low doorways, etc. The motors on both the purifier and the pump are equipped with push-button control.

Portable Electric Drill

A NEW line of heavy-duty portable electric drills has been brought out by the Standard Electric Tool Company, 1938 West Eighth St., Cincinnati, Ohio. This line is made in two styles and in five sizes rated at $\frac{1}{4}$- and $\frac{5}{16}$-in. with a grip handle and at $\frac{3}{4}$-, $\frac{7}{8}$- and 1-in. equipped with a Morse taper socket, spade handle and a feed screw.





Two types of standard electric drills

Universal-type motors are used. Chrome nickel steel gears run in grease, and the shafts are mounted on anti-friction ball bearings. The motor housings are of aluminum.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Largest Arc Welding Laboratory Soon to Open at Westinghouse Works

RIVETS and the iron castings are due to be supplanted in the near future by arc welding, according to a prophecy made by W. S. Rugg, vice-president, Westinghouse Electric & Manufacturing Company, in a statement announcing the near completion of the largest arc-welding laboratory in the world, at his company's East Pittsburgh headquarters.

"Arc-welding will, within a few years, supplant the rivet in structural work and, to a large extent, the foundry for cast machine parts," said Mr. Rugg.

"The progress that has been made in the arc welding of various types of structures is strikingly demonstrated in a review of Westinghouse applications of the new method of steel erection. Within a comparatively brief period we have erected by the arc-welding process two buildings in our Sharon, Pa., works; one building in our Derry, Pa., works; seven buildings in our East Pittsburgh, Pa., headquarters; a bridge 55 ft. long at Turtle Creek, Pa., and a bridge 175 ft. long at Chicopee Falls, Mass. Altogether, these structures involved the arc-welding of nearly 1,600 tons of steel.

"At the present time the Westinghouse company is planning three more buildings at Trafford, Pa., all of which will be welded."

The entrance of arc welding into the machinery fabrication field is given impetuos by the new Westinghouse arc-welding laboratory, according to Mr. Rugg. This structure will be 75 ft. wide, 170 ft. long and 40 ft. high. The structure houses a 50-ton crane and in addition to the installation of arc-welding equipment, it will have massive rolling and forming equipment to be used for forming and shaping the various parts that go into welded machinery. These include motor frames, generator frames, motor rotor rims and motor end bells.

A list of the products Westinghouse expects to weld in the future includes turbine generator frames, locomotive frames, synchronous motor frames and spiders, boxes, machinery bases, floor plates and tanks, miscellaneous machinery parts, industrial heating apparatus, steel pipes and shop furniture.

At the present time in East Pittsburgh a 26-ton turbine generator frame entirely welded is being fabricated on the shop floors. This generator, one of the largest in the country, will be installed in a New York station of the United Light & Power Company.

Saskatchewan Power Commission Indorses Government Ownership

In the Canadian province of Saskatchewan, the government is setting about building up a large centralized power system, proposing to draw all existing systems into one control after the manner of the province of Ontario. Enough water power is available in Saskatchewan, and plans are being made to form a steam-power pool based on present city plants, reinforced by a central generating plant at a central point not yet determined, the proposal being to link up Regina, Moose Jaw and Saskatoon, the three largest cities in Saskatchewan, by transmission lines of large capacity. The filling of the supply of energy required in the three cities under one central authority and the construction of a central plant to supply the maximum of current possible is the ultimate goal.

The costs of electrical power derived from coal have been carefully worked out by the commission for the five years 1930 to 1935, during which period the unit cost would be gradually reduced. On the predicted consumption the cost of production per kilowatt-hour in Regina would fall from 0.965c. in 1930 to 0.8675c. in 1935; Moose Jaw, 1.26c. to 1.9051c.; Saskatoon, 1.27c. to 1.082c., and Prince Albert, 1.722 to 1.265 cents.

The important features of a report made recently by the Power Commission are:

Full indorsement of the principle of government ownership as against private company operation.

Ultimate provincial-wide link-up of power distribution facilities.

Purchase and extension of existing municipal plants in Regina, Moose Jaw and Saskatoon, involving the sum of $6,500,000, to form the nucleus of a provincial system, and the acquisition also of the plants at Prince Albert and the Battlefords.

Connection of Moose Jaw and Regina plants by a transmission line as a first step in subsequent development of southern link-up, basis of northern circuit being created by joining the plants of Saskatoon, Prince Albert and the Battlefords.

Rebuilding Saskatoon plant at a cost of $1,500,000.

Creation of secondary town systems with generating plants at strategic points.

Eventual joining of all the systems under one central administration.

Municipalities to buy power at switchboard and fix cost to consumer, with special consideration for large users.

Discarding the idea of immediate development of water power as impracticable and costly, in favor of steam power, which is deemed more efficient and cheaper under circumstances likely to appertain for many years to come.

Encouragement of the use of electrical energy on the farms by adaptation of main transmission network to country needs, thus creating a demand.

De La Vergne Plant Moving to Philadelphia

More than $2,000,000 worth of tools and inventory of the De La Vergne Machine Company, one of the six subsidiaries of Cramp-Morris Industrials, Inc., are being moved from New York to the marine machine shops of The William Cramp & Sons Ship & Engine Building Company, at Richmond and Norris Streets, Philadelphia, which have been idle since Cramps stopped building ships in 1926. By November they will all be installed in the Philadelphia buildings, offering employment for several hundred additional skilled workers in the Kensington district.

From a manufacturing point of view the move is designed to increase efficiency of operation, effect economies and add to the capacity of the De La Vergne company, which is one of the oldest manufacturers of refrigerating machinery and Diesel engines in the country.

For about forty years the company occupied buildings covering approximately three city blocks at 138th Street and the East River in New York City. When the marine machine shops of the original Cramp company were taken over by the Cramp Engine Manufacturing Company in this city, their utility in connection with the operation of the De La Vergne subsidiary was examined by the management. Existing facilities and those that will be added cover between three and four acres of floor space.

Proximity of the shops of another subsidiary, the I. P. Morris Corporation, designers and constructors of hydraulic turbine machinery, also situated at Richmond and Norris Streets, added to the opportunity. Some of the tools and personnel of each company could be used interchangeably, contributing to continuous operation and employment and aid-

ing to flatten out peaks and valleys of production.

At present the bulk of manufacturing is still being done in New York. By September it will be about equally divided between New York and Philadelphia. By November all work will be done in the Philadelphia plant.

Information of the move was given recently by H. Birchard Taylor, president of Cramp-Morris Industrials, Inc., and by Charles C. James, treasurer of the same corporation. Mr. Taylor is also president of The William Cramp & Sons Ship & Engine Building Company, whose plant is still in process of liquidation.

"The present move is part of a definite plan developed at the time Cramp-Morris Industrials was incorporated. This plan involved the passing of ownership of the subsidiaries and non-marine departments of The William Cramp & Sons Ship & Engine Building Company to Cramp-Morris Industrials, Inc., an entirely independent company," said Mr. Taylor. "Its effect on the entire family of companies will be most beneficial."

Subsidiaries of Cramp-Morris Industrials, Inc., include also the Cramp Brass and Iron Foundries Company, the Federal Steel Foundry Company of Chester, Pa., and the Pelton Water Wheel Company, of San Francisco.

All of these, excepting the I. P. Morris Corporation, which was purchased many years ago, and those formed from departments of the old company, were acquired by Cramp over the past decade.

New Equipment For London Subway's Power Station

In connection with the London subway combine, the Neasden Power Station of the Metropolitan Railway is now to be rebuilt. The steam generation plant will consist of six vertical bent-tube boilers, fired with pulverized fuel, each of 9,050 sq.ft. of heating surface, corresponding to a normal evaporation of 80,000 lb. of water per hour and 100,000 lb. per hour maximum. These will replace 20 existing stoker-fired boilers. The maximum working pressure of the new boilers will be 300 lb. per sq.in. gage, with a maximum temperature of 750 deg. F. Air preheaters are to be installed without feed-water economizers which are expected to reduce the flue-gas temperature to about 270 deg. F. and delivering heated air to the combustion chamber at approximately 500 degrees.

The main features of the pulverized-fuel equipment are shorter over-all height of the boiler settings; the drying of the coal by passing air from the air heaters through the pulverizing mills, six in number, each with a capacity of six tons per hour; and much smaller combustion chambers, due to the use of burners of the turbulent type. This enables the combustion to be completed in 10 ft., instead of 30 ft. as hitherto required. At Neasden two burners only will be necessary for each boiler and will be located in the front of the combustion chamber instead of over the top.

Water walls will be installed on each side and also at the back of the furnaces, while the front wall with the two burners is not cooled. The air from the air heater will be partly discharged through the pulverizing mills and then supplied to the short-flame burners as primary air, while the remainder will go direct to the burners in the form of secondary air. It is expected that up to six tons of coal per hour per single burner can be burned.

Large Italian Hydro-Electric Project Nearing Completion

The huge new hydro-electric plant has been completed at Terni for the supply of power to Rome and a large section of Central Italy. For ages, at the beautiful Le Marmore Cascades, near Terni, which have been described by numerous writers as the most picturesque in Italy, a large volume of water power was wasted. The water was first used 40 years ago, when a plant was erected which ultimately produced 20,000 hp. In 1922 the Terni Ironworks started work on a large project to harness the entire power of the falls, which will produce a total of 400,000 hp. This undertaking is now nearing completion.

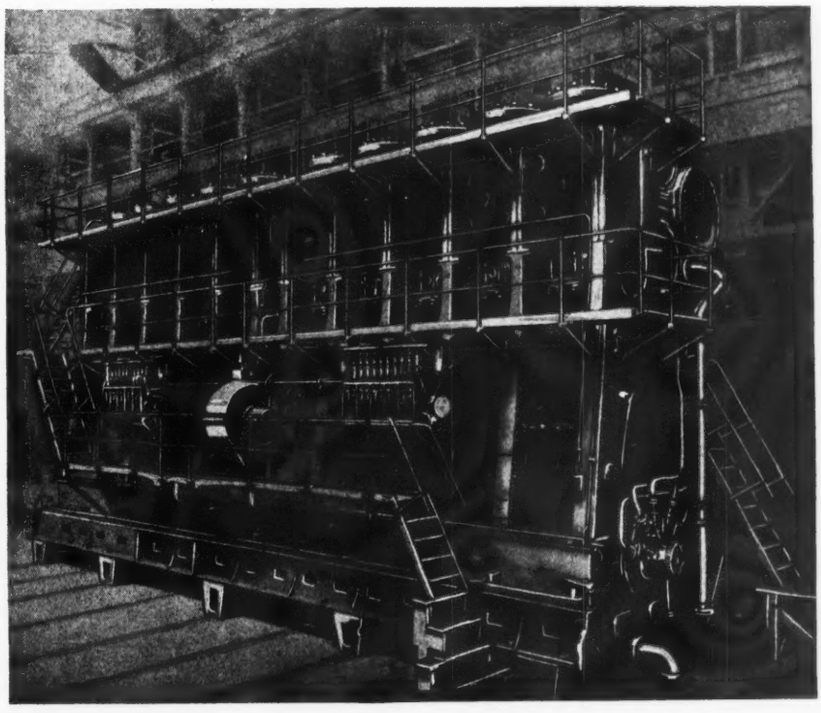
The water is drawn from a vast basin in the Abruzzi mountains, at one end of which Lake Piediluco forms, near the falls, a large permanent reservoir. The development has been made possible by enlarging an old Roman canal, dug in the year 481 of Rome, that is, more than 200 years before the Christian era, under the direction of the Republican Consul, M'Curius Dentatus, the conqueror of the Samnites.

From the start the canal caused numerous protests. The populace of Terni, or the ancient Interamnum, soon found that while the canal was advantageous to the inhabitants on the higher plateau, it was a permanent danger to themselves. It raised the level of the Nera and other streams rapidly, so as to flood and devastate all the valleys through which it flowed, and in some places it formed great lakes. The Roman Senate was appealed to through Aulus Pompeius. Cicero intervened as advocate for the inhabitants of Rieti and the high plateau and as a compromise he proposed that the canal should be deepened instead of being closed up.

The final decision is unknown, but it is curious that, after 2,000 years, the plan advocated by Cicero has been adopted by the Electric Company of Terni. The work of deepening and widening the canal was done, of course, with the aid of the most modern machinery and explosives.

The new plant is claimed to be the

Double-Acting Solid-Injection Diesel Rated at 11,700 Horsepower



That German engine builders are convinced of the advantages of the solid-injection principle is evidenced by the 11,700-hp. M.A.N. solid-injection engine shown in the illustration. This is one of two double-acting units built by the Machinenfabrik Augsburg-Nurnberg for the Berlin Electrical Works, to be used to carry the peak loads of this light plant. The engine has ten cylinders of 600 mm. (23.6 in.) diameter and 900 mm. (35.4 in.) stroke.

largest in Europe and will have, when completed, eight 50,000-hp. units, operating under a head of 400 ft. The power generated will go to Rome and other towns and cities of Latium and the Sabine district, to a large part of Abruzzi, and as far south as Frosinone, on the way to Naples, and may eventually also add to the electric power supply of Florence and a large part of Tuscany.

Large Power Project Started on St. Maurice River

Preliminary to one of the most important power development projects ever planned in Canada, the Shawinigan Water & Power Company, of Shawinigan Falls, Quebec, now has fifty engineers carrying out an extensive water-power survey of the upper reaches of the St. Maurice River. This survey, which will probably take about two years, follows upon the agreement recently entered into between the Shawinigan company and the province of Quebec for the development of a number of sites on the St. Maurice River. It is estimated that eventually there will be developed in the neighborhood of 1,000,000 hp. from the sites now being surveyed. The proposed expenditures of the company are estimated at approximately $50,000,000.

In the meantime the Shawinigan company is installing an additional 80,000 hp. in one of the plants at Shawinigan Falls, which will give the company a total development of 764,000 hp. Two units of 40,000 hp. each are being installed. It is expected the first unit will be in operation by the end of this year and that the second unit will begin operating some times in 1929. The expansion has been designed to meet the normal increases in the demand for power in the territories served by the company.

May Abandon N. Y. State Steam Power Station

That the State of New York may abandon its two-million-dollar steam generating power plant and purchase electricity for the lighting of state buildings from the New York Power & Light Corporation is said to be a possibility. When the new 33-story state office building at Albany is completed, the present equipment, it is said, will not generate sufficient power to care for the state's needs. That hydro-electric energy can be purchased from the New York Power & Light Corporation cheaper than the state can manufacture it by steam, and thus effect a saving to the taxpayers, is one of the arguments advanced why the state should abandon its present competition with private capital in this respect.

A change from state-generated power to that of the private corporation would bring up many problems, however. For one thing the state is supplying direct current while the local power corporation furnishes alternating current.

Another proposal is that the state purchase the power required for lighting and general power purposes and generate its own electricity for the operation of the elevators in the capitol, education and new state office buildings. This would not require the installation of much additional equipment and would retain in the service the present working force employed in the power plant.

Should the state decide to continue its present policy of generating electricity for all state purposes, the installation of much additional equipment in the present power house will be necessary. Its present facilities, it is said, are insufficient to serve the new building under construction. In all probabilities the legislature next year will have this problem before it for solution.

Coming Conventions

American Society of Mechanical Engineers, Twin-City regional meeting at St. Paul, Aug. 27-30; Boston regional meeting, Oct. 1-3; second national fuels meeting at Cleveland, Ohio, Sept. 17-20; Calvin Rice, secretary, 29 West 39th St., New York City.

American Welding Society, fall meeting at Philadelphia, Pa., Oct. 8-12; M. M. Kelly, secretary, 29 West 39th St., New York City.

Canadian Steel and Power Show at the University of Toronto Arena, Sept. 4-7; Campbell Bradshaw, secretary, 24 Front St., West Toronto, Canada.

Midwest Power Conference and Exhibition, at Chicago, Feb. 12-16; G. E. Pfisterer, secretary, 53 West Jackson Bld., Chicago.

National Association of Power Engineers, annual convention at Detroit, Sept. 11-15, and concurrently National Exhibitors' Assn. exhibit; Fred Raven, 417 South Dearborn St., Chicago.

National Association Practical Refrigerating Engineers, annual convention at Louisville, Kentucky, Nov. 20-23; E. H. Fox, secretary, 5707 West Lake St., Chicago, Ill.

National Exposition of Power and Mechanical Engineering will be held at the Grand Central Palace, New York City, Dec. 3-8. Address inquiries to the International Exposition Company, Grand Central Palace, New York City.

New England Water Works Association, annual convention at Montreal, Canada, Sept. 18-21, Frank J. Gifford, secretary, 715 Tremont Temple, Boston, Mass.

Stoker Manufacturers Association, fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Oct. 22-24.

Second Bituminous Coal Conference will be held at Pittsburgh, Nov. 19-22.

World Power Fuel Conference at the Imperial Institute, London, Sept. 24 to Oct. 6.

Boston Edison and New England Power to Pool Power Resources

Announcement of preliminary arrangements for pooling the power resources of the New England Power Association and the Edison Electric Illuminating Company of Boston is a first step toward the formation of a great superpower system that will eventually embrace all of New England. This consolidation will affect communities within an area of 9,000 square miles. The Edison Electric Illuminating Company serves Boston and 37 surrounding cities and towns. It also sells electricity in bulk to ten other light and power companies and municipalities.

The New England Power Association stretches over an area of 9,000 square miles in which it serves 250 communities with a population of 2,500,000. The association comprises the following companies: The New England Power Company, Connecticut River Power Company of New Hampshire, Rhode Island Power Transmission Company, Rhode Island Public Service Company, Bellows Falls Power Company, Lawrence Gas & Electric Company, Grafton County Electric Light & Power Company, Webster and Southbridge Gas & Electric Company and the Lowell Electric Light Corporation.

The arrangements involve an annual sale by the New England Power system to the Boston Edison of 150,000,000 kw.-hr. of primary power, and the exchange of electricity from time to time when one system can produce it more cheaply than the other. The pool of power resources should be of great benefit to the consumers of both systems.

A.S.M.E. Announces Program for New England Industries Meeting

Education and training for the industries, materials handling, aëronautics, applied mechanics, railroads, machine-shop practice, wood industries and power will be the general subjects of the technical sessions of the New England Industries Meeting of the A.S.M.E. to be held in Boston, Oct. 1-3, at the Statler Hotel.

The principal paper in the power field will be read by Frank M. Gunby, engineering member of Charles T. Main, Inc., Boston. He will discuss the power supply for New England industry. J. P. Den Hartog, of the Westinghouse Electric & Manufacturing Company, will read a paper entitled "The Mechanics of Plate Rotors for Turbo Generators."

Two papers of general interest in the management section will be "Progress in New England," by Wm. J. Fortune, and "Proper General Management of Industry," by Jerome R. George.

Fluid-Meter Research Started in Germany

Upon his return to America recently, J. M. Spitzglass reported that in Münich on July 6 the Verein Deutscher Ingenieure organized a new research committee for flow meters. Mr. Spitzglass, who is secretary of the A.S.M.E. Special Research Committee on Fluid Meters, was present at this meeting and delivered an address on the history and work of the society's committee.

Mr. Spitzglass left this country in July, 1927, for the purpose of studying certain phases of the theory of flow meters in Germany and enlisting the co-operation of its engineers in the work

of the A.S.M.E. committee. His mission was highly successful and it is expected that the organization of the German committee in which Mr. Spitzglass holds membership will greatly assist in the interchange of data and opinions between the two groups interested in the development of this important subject.

Largest Impulse Waterwheels Go Into Service

On Aug. 15 Big Creek 2A plant of the Southern California Edison Company was put into operation. In this plant are installed the two largest impulse wheels built. These are rated at 56,000 hp. under a 2,300-ft. head. Each unit consists of two overhung waterwheels with a generator mounted between the two wheels.

There are only two bearings on each unit with the generator between them and the waterwheels overhung. The shaft is about 35 ft. long, has a diameter of 40 in. where the generator rotor is mounted, and weighs nearly 100,000 lb. The two bearings on each unit are probably the largest oil-ring type that have been constructed. They have ball-and-socket seats, babbitted shells, 32-in. bore and are seven feet long. The total load to be carried by these bearings is about 700,000 pounds.

Each bucket on the wheels will receive an impact force of 90,000 lb. at full load from a water jet 8½ in. in diameter, having a velocity of 255 miles per hour.

The power generated in the plant will be stepped up to 220,000 volts for transmission. On the company's Big Creek San Joaquin system there is generated about one-half million horsepower which is supplemented at over 400,000 hp. of steam plants, making the total capacity available in the system of nearly one million horsepower.

Business Notes

The Chicago Pneumatic Tool Company announces the completion of a large new foundry at Franklin, Pa., in order to take care of the increasing demand for its engines and compressors and to assure a uniform quality in its castings. At this foundry all gray-iron castings for compressors and engines will be made. This new foundry is adjacent to the main plant which consists of power plant, machine shop, erecting floors, pattern shop, offices and shipping platforms.

The Linde Air Products Company announces that four new Linde plants have recently started production of oxygen and are serving the local demand in their respective localities. On July 3 a plant at 631 S. 17th St., Harrisburgh, Pa., started operating in charge of J. J. Naber. A plant at Seventeenth and W. Lawrence Sts., Allentown, Pennsylvania, in charge of W. Barber, began production on July 18. On Aug. 1, the Shreveport, La., plant, at Foster and Thomas Sts., in charge of F. T. Rueger, started operating. Last of all, a plant at First Ave. and B St., South Charleston, W. Va., was added to the chain. Ed. Pohlman is superintendent at the latter plant, which started manufacturing Aug. 10. The opening of these plants brings the total up to 52 Linde oxygen producing plants throughout the country.

The Prest-O-Lite Company, Inc., has lately added two new plants to its nation-wide chain, making the total 33. These will serve near-by industry with dissolved acetylene, used in oxyacetylene welding and cutting. A plant in charge of H. A. Smith, at 631 S. 17th St., Harrisburg, Pa., started production on July 12, and another at Seventeenth and W. Lawrence St., Allentown, Pa., J. W. Summers, superintendent, began operations on July 21.

The Chain Belt Company has started work on a new manufacturing building on its 59-acre tract at 39th and Orchard Streets, Milwaukee. This is the fourth unit to be erected and is a part of a general plant for extension. The main office is still on the Sixteenth Street Viaduct where the company has the gray-iron foundry and the chain assembly plant, machine shop and another assembly building.

The Keasby & Mattison Company announces that William Jacobsen, recently associated with the Asbestos & Mineral Corporation, New York City, has been appointed sales manager of their fiber department at Ambler, Pa.

Trade Catalogs

Crawler Crane—The new "Built for Service" crawler crane book No. 995 just issued by Link-Belt Company, Chicago, Ill., is an attractive and complete catalog covering the line of gasoline, Diesel and electric crawler cranes of capacities up to and including the 2 cu.yd. heavy-duty machine as well as standard locomotive cranes. The book is generously illustrated to show the use of the dragline, dipper and trench shovels and other attachments. Data are given on lifting capacities, approximate operating speeds, line pull, tractive effort, etc. The tables in which these data are arranged have been supplemented by line drawings which show dimensions for operating limits.

Flue Blower—A four-page bulletin of the Dillon Automatic Flue Blower Company, 5600 Garfield Ave., Kansas City, Mo., describes that company's automatic flue blower for use on any tubular boiler.

Fuzon Arc Welders—In a four-page bulletin the Fusion Welding Corporation, 103rd St. & Torrence Ave., Chicago, Ill., gives a description of its Fuzon arc welders. These units are either motor or gas-engine driven and may be had in stationary or portable equipment.

Carbon Brushes — The National Carbon Company, Cleveland, Ohio, in its new 40-page catalog, B-128, gives a lot of valuable material on the application of brushes to electrical machines. Such subjects as physical characteristics of brushes, grades of brushes, standardization and mechanical details of brushes, standard terminals and cables, and other information, are included.

High-Pressure Centrifugal Pumps —Present-day high steam pressures call for centrifugal feed pumps capable of operating against high pressures. The Pennsylvannia Pump & Compressor Company, Easton, Pa., has issued Bulletin 212 covering its class OMS high-pressure pumps built to meet this demand. This catalog is well illustrated with views of pump installations and shows the design in detail.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except **Pittsburgh gas slack:**

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.25@$2.60
Kanawha	Columbus	1.25@ 1.60
Smokeless	Cincinnati	2.00@ 2.25
Smokeless	Chicago	2.00@ 2.25
S. E. Kentucky	Chicago	1.35@ 1.60
Steam	Pittsburgh	1.80@ 1.90
Gas Slack	Pittsburgh	1.20@ 1.30
Big Seam	Birmingham	1.25@ 1.75
Anthracite (Gross Tons)		
Buckwheat	New York	$2.75@$3.00
Birdseye	New York	1.60

FUEL OIL

New York—Aug. 23, f.o.b. Bayonne, N. J.: 28@34 deg., Baumé, industrial use, tank-car lots, 5c. per gal.; 36@40 deg., furnace, tank-car lots, 7c. per gal.

St. Louis—Aug. 16, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.35 per bbl. or 42 gal.; 26@28 deg., $1.40 per bbl.; 28@30 deg., $1.45 per bbl.; 30@32 deg., $1.50 per bbl.; 32@36 deg., gas oil, 4.3c. per gal.; 38@40 deg., 4.98c. per gal.

Pittsburgh—Aug. 14, f.o.b. local refinery, 30@34 deg., fuel oil, 5½c. per gal.; 36@40 deg., 5¾c. per gal.

Philadelphia—Aug. 22, 26@30 deg., $1.94@$2.01 per bbl. or 42 gal.; 13@19 deg., $0.995@$1.065 per bbl.; 22 plus, $1.52@$1.57 per bbl.; 27@30 deg., $2.14@$2.21 per bbl.

Cincinnati—Aug. 13, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—Aug. 11, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 57½@ 60c. per bbl.; 26@30 deg., 75c. per bbl.; 30@32 deg., 90c. per bbl.

Boston—Aug. 20, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.4c. per gal.; 28@ 32 deg., 5.6c. per gal.

Dallas—Aug. 14, f.o.b. local refinery, 26@30 deg., $1.15 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Sacramento — Roxbury Hydraulic Mines, Inc., Financial Center Bldg., San Francisco, has made application for appropriation of 150 cu.sec.ft. of water from Scott River in Siskiyou county here for mining and power purposes, to include power house, etc. Estimated cost $300,000.

Calif., San Louis Obispo—State Highway Comn., will receive bids until Sept. 5, for the construction of a maintenance station including a pump house, etc. C. H. Purcell, Forum Bldg., Sacramento, is engineer.

Calif., Westley—West Stanislaus Irrigation Dist., E. Smith, Secy., will receive bids until Sept. 1, for the construction of six pump houses.

Fla., Cedar Key—Gulf Utilities Co., New Port Richey, have acquired the plant of the Cedar Key Light & Power Co. here and plans a larger unit to replace small unit now in use.

Ill., East St. Louis — St. Louis Air Transport & Terminal Co., c/o M. C. Steinberg & Co., Boatmen's Bank Bldg., St. Louis, Mo., is having preliminary plans prepared for the construction of an airport including hangars, shops, power house, etc., here. Estimated cost $1,000,000. P. R. Love and T. P. Sultan, 6625 Delmar Blvd., St. Louis, Mo., are engineers.

Ind., Anderson—Indiana General Service Co., is having plans prepared for the construction of a large electrical power substation. This will supply one half of the power used by the large Delco-Remy plants near here.

Ia., Cedar Rapids — City, H. F. Bloomquist, Supt., plans waterworks improvements including deep well, water softening and pumping plants, etc. Estimated cost $550,000. H. R. Green Co., Bever Bldg., is consulting engineer.

Kentucky—Cumberland Falls Hydro-Electric Co., c/o Insull Interests, Chicago, Ill., has made application for permit to construct a hydro-electric plant on the Cumberland Falls including the erection of a dam 80 ft. high and 3,500 ft. long and power house, 30,000 kw. capacity. Estimated cost approximately $7,000,000.

Kentucky—R. H. McNeil, Washington, D. C., has made application for permit to construct a hydro-electric development on the Tennessee River, 42 miles above the mouth of the river at Aurora Dam site near Paducah. Plans include a power plant, 132,400 hp. capacity and dam 60 ft. high.

Mass., Cambridge (Boston P. O.)—City, J. J. Scully, Chn. Water Bd., will receive bids until Sept. 5, for the construction of a pumping station at Lake View Ave. and Worthington St. Estimated cost $100,000. E. T. P. Graham, 171 Newbury St., Boston, is engineer.

Minn., Alexandria — City awarded contract for the construction of a sewage disposal plant and pumping station to Theodore Jensen, St. Cloud, Minn. Estimated cost $65,000.

N. J., Hammontown—New Jersey Canners Corp., c/o Edwards & Green, 540 Federal St., Camden, Archts., plans the construction of a cold storage and refrigeration plant here. Estimated cost $100,000.

N. J., Union — Central Atlantic Ice Co., Park Ave., Summit, is having plans prepared for the construction of an ice plant on Grandiren Ave., here. Estimated cost $80,000. Private plans.

N. Y., Buffalo — Dept. of Public Works, G. Fisk, Comr., Municipal Bldg., will receive bids until Sept. 4 for the construction of an airport, including central heating plant, etc., at Genesee St. and Cayuga Rd. Estimated cost $55,000. H. Beck, 374 Delaware St., is city engineer.

N. Y., New York—New York Edison Co., J. W. Lieb, V. Pres., 130 East 15th St., plans extensions to electrical galleries and turbine room at electric power plant, 701 East 14th St. Estimated cost $1,850,000. T. E. Murray, 55 Duane St., is engineer.

O., Columbus — Dept. of Welfare, J. E. Harper, Dir., Ninth and Oak Sts., awarded contract for the construction of a 98 x 105 ft. power house at Columbus State Hospital, West Broad St. to B. E. Gardner, Portsmouth. Estimated cost $52,091.

Texas—San Antonio Public Service Co., 201 North St. Marys St., San Antonio, plans the construction of a large sub-station to supply electric power to cement plant of Smith Bros. Inc., 117 Villita St., now in course of construction. Estimated cost $100,000. Terrell Bartlett, Engrs., Calcasieu Bldg., San Antonio, are engineers.

Virginia—Virginia Electric & Power Co., plans to expend $12,000,000 in improvements above Roanoke Rapids and along the Roanoke River. The company has made application for permission to make surveys for the construction of two hydro-electric power dams at Buggs Island and Roanoke Rapids. The two dams, it is reported, will mean the erection of plants that will furnish a total of 100,000 kw.

Tenn., Cookeville—Putnam County, voted $100,000 bonds for the construction of a hydro-electric plant.

Ont., Port Colborne—City, C. E. Steele, Mayor, will receive bids early in September for the construction of a sewage disposal plant and pumping stations, etc. Estimated cost $500,000. Wynne Roberts Son & McLean, Metropolitan Bldg., Toronto, are engineers.

Equipment Wanted

Pumping Unit—City of Daytona Beach, Fla., E. Wheeler, Mgr., additional electric pumping unit for municipal waterworks.

Pumps — H. Magnus, Secy., Bd. of Municipal Works, Winona, Minn., will receive bids until Sept. 1 for furnishing and installing two deep well centrifugal pumps, etc., for proposed waterworks improvements.

Pumps—City of Edmonds, Wash., three motor driven deep well turbine pumps, etc. for proposed waterworks improvements. Estimated cost $150,000.

Pumps, Etc.—City of South Sioux City, Neb., two pumps, etc. for proposed sewage system. Estimated cost $95,000.

Refrigeration Equipment — Dept. of Health, 505 Pearl St., New York, N. Y., will receive bids until Aug. 31, for furnishing and installing refrigeration equipment in Mortuary and Laboratory buildings at Willard Parker and Riverside Hospitals.

Boiler Plant Equipment — Public Works Office, Naval Station, Cavite, P. I., plans removal of boiler plant equipment and its replacement with two water-tube boilers, motor driven hot well pump, oil burners, metering feed water heater, etc., also installation of boiler feed and oil pumps furnished by the Government at Naval Hospital, Canacao, P. I.

Engine — W. S. Bressley, Clk., Wayne, Neb., will receive bids until Sept. 6 for a 600 hp. Diesel oil engine, for proposed waterworks improvements. Estimated cost $54,000.

Generators and Turbines, Etc.—Dept. of Public Works, Supplies & Tenders Board, Wellington, N. Z., will receive bids until Nov. 27 for 16,666 kva. generators and turbines, two turbines complete, two generators and exciters complete, etc.

Power Plant Equipment — Bureau of Yards & Docks, Navy Dept., Washington D. C., will receive bids until Sept. 5 for power plant equipment, including water tube boilers, boiler feed, vacuum and condensate pumps, metering feed water heater, refrigeration and ice making plant, switches, transformers, etc., also the installation of a Diesel engine generator set and other apparatus furnished by the Government at Marine Barracks, Quantico, Va.

Pump—Bd. of Water Comrs., 176 East Jefferson Ave., Detroit, Mich., will receive bids until Sept. 6 for one 6 m.g.p.d. electric motor driven centrifugal pump with auxiliary equipment for Northern Yard.

Pumps, Air Compressor, etc.—Mayor and Bd. of Aldermen, Plain Dealing, La., will receive bids until Aug. 30 for two 500 g.p.m. motor driven fire pumps, one motor driven air compressor, etc., for proposed waterworks improvements.

Refrigeration Equipment — Budweiser Brewing Co. of Canada, A. C. Caldwell, Mgr., Dundas, Ont., plans the installation of complete new machinery and equipment including refrigeration equipment for brewery. Estimated cost $100,000.

Refrigeration Equipment — Dept. of Mental Hygiene, Capitol, Albany, N. Y., will receive bids until Sept. 12 for refrigeration equipment for Rome State School, Rome, N. Y.

Industrial Projects

Calif., Sacramento — RICE MILLING PLANT—Capital Rice Milling Co., will receive bids about Sept. 1 for reconstruction of plant recently destroyed by fire. Estimated cost $200,000. Architect not announced.

Calif., Sacramento—PAPER FACTORY and WAREHOUSE—Zellerbach Paper Co., 1213 Front St., awarded contract for a 4 story, 50 x 125 ft. factory and warehouse, to Campbell Construction Co., 800 R St. Estimated cost $160,000.

Conn., Hartford—BRASS FOUNDRY—M. S. Little Mfg. Co., 151 New Park Ave., is receiving bids for a 1 story, 50 x 120 ft. factory. Estimated cost $40,000. W. W. Dolliver, 136 Kent St., is architect.

Conn., Norwich — THERMOS BOTTLE FACTORY — American Thermos Bottle Co., Laurel Hill Ave., awarded contract for the construction of a plant to Archibald Torrance, Prospect St. Estimated cost $125,000.

Ill., Chicago—FACTORY—International Harvester Co., 606 South Michigan Ave., awarded masonry contract for a 1 story, 180 x 510 ft. factory at 2600 West 31st St. Estimated cost $170,000.

Mass., Charlestown (Boston P. O.) — MILK PLANT—H. P. Hood & Sons, 494 Rutherford Ave., awarded contract for the construction of a 3 story, 175 x 285 ft. milk plant to Turner Construction Co., 178 Tremont St., Boston. Estimated cost $300,000.

Tex., Amarillo—HELIUM PLANT—U. S. Government, Bureau of Mines, Washington, D. C., awarded contract for the construction of a helium plant here, to James T. Taylor, 707 First National Bank Bldg., Ft. Worth. Estimated cost $500,000.

Tex., Big Springs—OIL REFINERY—Big Springs Pipe Line Co., c/o C. Groff, Douglas Hotel, will build a 5,000 bbl. oil refinery. Estimated cost $100,000. Machinery and equipment will be required.

Tex., Mission — CONCRETE PIPE PLANT — W. F. Liston & Son, Harlingen, is having plans prepared for the construction of a plant near here. Estimated cost $50,000. Private plans.

Tex., San Benito—PACKING PLANT—Texas Citrus Fruit Growers Exchange, c/o J. Shary, Pres., Mission, Tex., will soon receive bids for the construction of a packing plant, here. Estimated cost $100,000. H. H. Ewing, Mission, is engineer.

Wis., Madison — PAINT and GLASS FACTORY — Mautz Paint and Glass Co., having plans prepared for the construction of a paint and glass factory including steam heating and ventilating systems, passenger and freight elevators. Estimated cost $30,000. Law, Law and Potter, 116 N. Murray St., are architects.

N. B., Dalhousie—PAPER MILL, ETC.—International Paper Co., 100 East 42nd St., New York, N. Y., awarded contract for the construction of a group of main buildings consisting of paper mill, groundwood mill, sulphite mill, slasher mill, also power plant, two railway sidings, etc. here, to Domili Construction Co. of Canada, Ltd., Montreal, Que. Estimated cost approximately $15,000,000.

N. S., Halifax—PAPER MILL—Mersey Paper Co., Ltd., C. H. L. Jones, Pres., plans the construction of a paper mill on Mersey River in Queens county. Estimated cost $5,000,000.